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# Massive Microbiology

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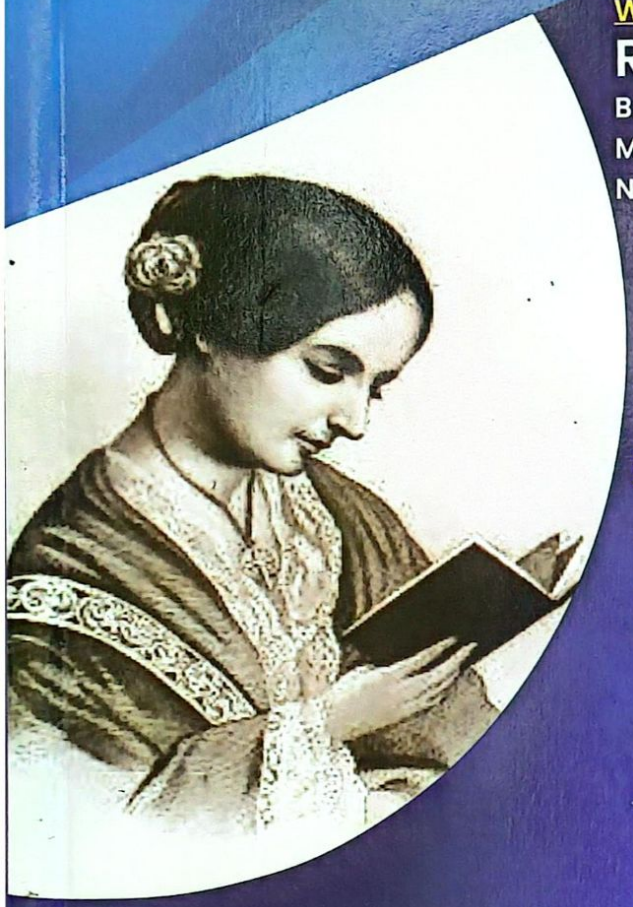

Written by

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- Diploma in Nursing Science & Midwifery.
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# Massive Microbiology

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## Dedicated to:

This book is respectfully dedicated to all nursing students and teachers who are devoted to learning, teaching, and serving humanity through the noble profession of nursing.

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# Acknowledgement

First and foremost, I express my deepest gratitude to Almighty God. His endless blessings, guidance, and wisdom have given me the strength, patience, and perseverance to complete this long and challenging journey.

Writing this book has not been just a scholarly effort but a meaningful journey of learning and discovery. From the very beginning, I realized that students often struggle to understand complex topics, and there was a need for a book that is both comprehensive and easy to understand. This goal has been my constant motivation throughout.

I am profoundly grateful to my family for their unwavering support, love, and patience. Their encouragement sustained me through the toughest moments of writing and research, allowing me to stay focused and determined even when challenges seemed overwhelming.

I extend my sincere thanks to my colleagues, mentors, and educators. Their valuable guidance, insightful suggestions, and constructive feedback greatly enriched the content of this book. They helped me present complex concepts in a clear, practical, and student-friendly manner, often suggesting real-life examples and explanations that enhanced comprehension.

I also wish to acknowledge the authors and researchers whose works served as references. Their contributions provided a solid foundation for this book and inspired me to present knowledge in an organized and accessible way for learners.

Special thanks to my students, whose curiosity, questions, and enthusiasm have been a constant source of inspiration. Their eagerness to learn reminded me of the importance of clarity, precision, and relevance in teaching, motivating me to make the material more engaging and applicable.

I am also grateful to the institutions, libraries, and resources that facilitated access to information, helping me gather authentic and up-to-date content for this book. Without their support, compiling this work would have been far more difficult.

Finally, I acknowledge that any errors, omissions, or shortcomings in this book are entirely my own. I welcome constructive criticism from readers, which will help me improve future editions.

This book is syllabus-based; it is a reflection of my journey of learning, inspiration, and perseverance.

**Renu Ara Begum**

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# Preface

Microbiology is a cornerstone of the health sciences, bridging fundamental scientific principles with clinical practice. For nursing and other healthcare professionals, a sound understanding of microorganisms, infectious diseases, and immunity is essential for ensuring safe patient care as well as achieving academic excellence.

This book has been written as a syllabus-based guide book, with all topics arranged strictly according to the prescribed curriculum. Each question and answer is supported by standard references, and a complete list of references is provided at the end of the book to ensure academic authenticity.

**Massive Microbiology** has been developed as a comprehensive yet student-friendly textbook. It is organized into nine sections and twenty-eight chapters, covering bacteriology, virology, parasitology, mycology, helminthology, immunology, infectious diseases, and sterilization and disinfection.

The book is designed primarily for the following nursing programs:

- Diploma in Nursing Science & Midwifery
- Diploma in Midwifery
- B.Sc. in Nursing (Basic)
- B.Sc. in Nursing (Post Basic)

The book includes:

- 1,200 Multiple-Choice Questions (MCQs) for effective examination preparation
- 340 Viva questions for concise revision, with page references
- 50 scenario-based questions to assess applied knowledge in diagnosis, transmission, and prevention.
- Complete syllabus coverage with clear page references
- Approximately 570 pages of systematically organized content

The content has been compiled from authoritative textbooks and up-to-date guidelines, including:

**Textbooks:**

Ananthanarayan & Paniker's *Textbook of Microbiology* (11th ed.), Chatterjee's *Parasitology* (13th ed.), Davidson's *Principles and Practice of Medicine* (24th ed.), Levinson's *LANGE Review of Medical Microbiology & Immunology* (16th & 17th eds.), Mandell's *Principles and Practice of Infectious Diseases* (9th ed.), Murray's *Medical Microbiology* (9th ed.), Choudhury's *Modern Medical Microbiology* (5th ed.), Potter & Perry's *Fundamentals of Nursing* (10th ed.), and Park's *Preventive and Social Medicine* (19th ed.).

**Guidelines and Updates:** World Health Organization (2018–2023), Centers for Disease Control and Prevention (CDC, 2021–2024), American Heart Association (2015 & 2024), American Academy of Pediatrics (2023), American Academy of Otolaryngology (2022), and American Lung Association.

I am deeply grateful for the constant support and encouragement of my family, friends, colleagues, my beloved son and daughters, and my husband, whose patience, understanding, and inspiration made this work possible.

Despite sincere efforts, some errors or omissions may remain. I humbly request readers to kindly excuse any such mistakes and to provide constructive feedback for the improvement of future editions.

It is my sincere hope that **Massive Microbiology** will serve as a textbook but also as a trusted guide for students, teachers, and healthcare professionals in their academic pursuits and clinical practice.

**Renu Ara Begum**
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Rajshahi Nursing College, Rajshahi
**Author**, *Massive Microbiology*

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500. Cervical Scrape- 596-597
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504. Stool collection- 598-599
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506. Blood Collection- 600
507. Controlling microbial growth 601
508. Action of Microbial Control Agents 602-603
509. Alteration of membrane permeability 603
510. Damage to Proteins and Nucleic Acids 603-604
511. Agents that Damage Nucleic Acids 604
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526. Osmotic Pressure (Physical Method) 611
527. Chemical methods (Sterilization) 611-612
528. Filtration- 612
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# Basic Science (Microbiology)- Diploma in Midwifery.

| Lessons | Topic & Page | Hours |
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| 13 | ▪ Introduction of microbiology and parasitology-10<br>▪ Scope of microbiology and parasitology -10-11<br>▪ History of microbiology -12-14<br>▪ Introduction to bacteria-29, virus-154 and parasitology-292<br>▪ Microbes and human diseases 289-292<br>▪ Normal microbiota (Flora)-19-20 | 2 |
| 14 | Nature, reproduction, growth, and transmission of common microorganisms and parasites in Bangladesh:<br>Introduction to types of bacteria:-29-30<br>Cocci: 44-62<br>▪ Diplococci (Pneumonia 48-50, Gonorrhea 57-59)<br>▪ Streptococci (Throat infection-539, Rheumatic fever-513)<br>▪ Staphylococci (Wound -493 and skin infection 549) | 2 |
| 15 | Introduction to types of bacteria continued :Bacillus<br>▪ Gram positive (Tetanus 65-69, Botulism 69-72, Anthrax 77-78)<br>▪ Gram negative (E. Coli 108-109, Shigella 101-104 and Salmonella 92-100)<br>▪ Gastrointestinal infection 524-531) | 2 |
| 16 | Introduction to types of bacteria continued:<br>▪ Acid-fast (Tuberculosis 80-87, Leprosy 87-92)<br>▪ Vibrio-(Cholera) 109-111<br>▪ Spirochetoses (Syphilis 118-121, Hemorrhagic jaundice 595-596)<br>▪ Helicobacter pylori (Peptic ulcer) 111-116 | 2 |
| 17 | Identification of microorganisms:<br>Microscopy: Light microscopy 15-17<br>Methods for light microscopic examination:<br>▪ Preparing smear for staining 281<br>▪ Simple staining 281-282<br>▪ Different stains (Gram stain, Acid-fast stain) 282-284 | 2 |
| 18 | Identification of microorganisms:<br>Culture of microorganisms:<br>▪ Basic principles 276<br>▪ Media 274<br>▪ Culture techniques 276 | 2 |
| 19 | Lab-1: Microscopic study of bacteria-1 | 2 |
| 20 | Lab-2: Microscopic study of bacteria-11 | 2 |
| 21 | Introduction to viruses:<br>Use common viruses affecting pregnancy and newborn babies as examples-<br>▪ Pneumotropic (Viral pneumonia 545-547, influenza 166-168)<br>▪ Neurotropic (Viral encephalitis 520-521, Polio 195-200, Rabies 221-222)<br>▪ Viscerotropic (Infectious hepatitis 244-253, Dengue fever 223-229, Yellow fever 240-242) | 2 |
| 22 | **Introduction to viruses continues**:<br>▪ Dermatropic (Measles 176-179, Chicken Pox 207-211, Warts 214-216)<br>▪ Human Immunodeficiency Virus or HIV and Acquired Immune Deficiency Syndrome of AIDS. 170-174 | 2 |
| 23 | Introduction to Fungi using common fungi affecting pregnancy and newborns as examples:<br>▪ Dermatophyte: Tineas or ring worms (Mycosis) 413-414<br>▪ Candida: Candidiasis (Thrust, vaginal yeast infection) 418-420 | 2 |



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| | | |
|---|---|---|
| 24 | Lab-3: Microscopic study of viruses and fungi | 2 |
| 25 | Lab-3: Microscopic study of viruses and fungi | 2 |
| 26 | Introduction to Parasite use common parasites affecting pregnancy and newborns as examples-<br>▪ Parasites: Protozoa and Helminths 302-394<br>▪ Plasmodium falciparum, vivax, ovale, malariae (Malaria) 325-332<br>▪ Leishmania donavani (Kala-azar or dum dum fever) 332-338<br>▪ Entamoeba histolytica (Amoebic dysentery) 304-308 | 2 |
| 27 | Introduction to Parasite continues:<br>▪ Tapeworms, pinworms, hookworms and roundworms 339-394<br>▪ Trichomonas vaginalis (Trichomonas) 321-324<br>▪ Chlamydia 61-62 | 2 |
| 28 | Lab-5: Microscopic study of parasites | 2 |
| 29 | Microorganisms and human diseases: 289-292<br>Capabilities of a pathogen how they turn into diseases:290-291<br>▪ Maintaining reservoirs : Human/animal 289<br>▪ Gating and entering host 290<br>▪ Adhering to a body surface 290<br>▪ Evading the body 290-291 | 2 |
| 30 | Microorganisms and human diseases: 289-292<br>Capabilities of a pathogen how they turn into diseases continued:<br>▪ Evading the body`s defense. 290-291<br>▪ Multiplying in the host. 291<br>▪ Leaving the body. 291 | 2 |
| 31 | Identification of microorganisms:<br>Culture of microorganisms<br>▪ Basic principles. 276<br>▪ Media. 274-286<br>▪ Culture techniques. 276 | 2 |
| 32 | Examination of human specimens: 596-600<br>▪ Swabs (Nose, throat, cervix, ulcers and wounds) 596-600<br>▪ Sputum 279<br>▪ Stool -279-280, 598-599<br>▪ Urine -278, 599-600 | 2 |
| 33 | Lab-6: Preparation and collection of human specimens. | 2 |
| 34 | Lab-7: Preparation and collection of human specimens. | 2 |
| 35 | Review of learning | 2 |
| 36 | Controlling of microbial growth. 600-611<br>Sterilization<br>▪ Physical methods. 603-604<br>▪ Heat-Moist-Autoclaving 606, boiling. 606<br>▪ Dry-Flaming.609 | 2 |
| 37 | Chemical methods-Hand wash, chlorination, savlon 609-610 | 2 |
| 38 | Lab-8: Controlling of microbial growth | 2 |
| 39 | Immune system 427-484<br>▪ Adaptive immunity 434-438<br>▪ Active and Passive immunity 436-438 | 2 |
| 40 | Immunization-Active immunization 477-483<br>▪ Vaccines: Types and characteristics 480-483<br>▪ Bangladesh and WHO Health Care Policy on 476<br>✓ Active immunization 477 | 2 |

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| | | |
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| | ✓ Passive immunization 477-478 | |
| 41 | Lab-9: Clinical visit (Pathological lab) | 2 |
| 42 | Prevention and controlling of microorganism.<br>▪ Hospital acquired infection. 502-503<br>▪ Common hospital acquires infection. 503, 552, 526, 529, 538-543, 538-561, 83, 244 | 2 |
| 43 | Control of hospital acquired infection. 504-508 | 2 |
| 44 | Principles of community based primary care including determinants of health. 505 | 2 |

## Microbiology and Parasitology
## Diploma in Nursing Science and Midwifery

| Hours | Units | Contents & Page |
|---|---|---|
| 4 hrs. | 1 | Course orientation.<br>▪ Introduction to Microbiology and Parasitology. 10<br>Scope of Microbiology and Parasitology 10-11<br>▪ Chemotherapy 17<br>▪ Immunology 427-484<br>▪ Virology 153-254<br>Microbes and human diseases. 289-292<br>Introduction to microscope. 15-17 |
| 4hrs | 2 | Nature, reproduction ,growth and transmission of common microorganisms and parasites in Bangladesh:<br>Bacteria :29-140<br>Cocci-44-62<br>▪ Diplococci (Pneumonia-48-50, Gonorrhea 57-59)<br>▪ Streptococci(Throat infection 539, Rheumatic fever 513)<br>▪ Staphylococci(Wound -493 and skin infection 549)<br>Bacilli-63-117<br>❖ Gram positive (Tetanus 65-69, Botulism 69-72, Anthrax 76-78)<br>▪ Gram negative (E. Coli 108-109, Shigella 101-104 and Salmonella 92-98, Gastrointestinal infection 524-531)<br>▪ Acid fast (Tuberculosis 80-87, Leprosy 87-92)<br>Spiral form. 117-121<br>▪ Vibrio (Cholera.) 109-111<br>▪ Spirochetes (Syphilis 117-121, Hemorrhagic jaundice 595-596)<br>▪ Helicobacter pylori.(Peptic ulcer). 111-116 |
| Lab-4 hrs. | | Microscopic study of bacteria |
| 3hrs | 3 | Viruses 153-254<br>▪ Pneumotropic (viral influenza) 165-168<br>▪ Neurotropic (Viral encephalitis 520-521, Polio 195-200, Rabies 221-222)<br>▪ Viscerotropic (Infectious hepatitis 244-253, Dengue fever 223-230, Yellow fever 240-242)<br>▪ Dermatropic (Measles 176-179, Chicken Pox 207-211, Warts 214-216) |
| 2hrs | 4 | Fungi:409-426<br>▪ Dermatophyte: Tineas or ring worms (Mycoses 412-421<br>▪ Candida : Candidiasis (Thrush) 418-420<br>▪ Cryptococosis (C. neoformans): Cryptococosis 420-421 |
| Lab-4 hrs. | | Microscopic study of viruses and fungi |

| | | |
|---|---|---|
| 3 hrs. | 5 | Parasites:293-393<br>▪ Protozoa and Helminths 302-394<br>▪ Plasmodium falciparum, vivax, ovale, malariae,(Malaria) 325-331<br>▪ Leishmania donovani (kala azar or dum dum fever 332-338<br>▪ Entamoeba histolytica (amoebic dysentery) 304-308<br>▪ Tapeworms, pinworms, hookworms and round worms 339-394<br>▪ Trichomonas vaginalis (trichomoniasis) 321-324 |
| Lab-4 hrs | | ▪ Microscopic study of parasites |
| 4hrs | 6 | Microorganisms and human diseases: Capabilities of a pathogen 22-23, 289-292<br>▪ Maintaining reservoirs: Human /animal 290<br>▪ Getting and entering the host 290<br>▪ Adhering to a body surface 290<br>▪ Evading the body's defense 290-291<br>▪ Multiplying in the host 291<br>▪ Leaving the body 291 |
| 3hrs | 7 | Immunization: Active immunization 477-483.<br>▪ Vaccines: types and characteristics 480-483<br>Bangladesh and WHO Health Care policy on active and Passive immunization. 476 |
| 4hrs | 8 | Prevention and controlling of microorganisms. 601-614<br>▪ Universal precautions (UP) 506-508<br>▪ Microorganisms in the hospitals 503<br>▪ Mode of transmission 492 |
| 10 hrs. | 9 | Controlling of microbial growth 601-614<br>Actions of microbial control agents 602-603<br>▪ Alterations of membrane permeability 603<br>▪ Damage to proteins and nucleic acids 603-604<br>Physical methods :604-611<br>▪ Heat :moist (autoclave), dry (flaming), pasteurization 607-610<br>▪ Filtration & Radiation 579, 612<br>▪ Osmotic pressure 611<br>Chemical methods : 611-612<br>▪ Effective disinfection & Disinfectants 604-605 |
| 4hrs | 10 | Hospital-Acquired Infection 504<br>▪ Microorganisms in the hospitals 503<br>▪ Compromised host 613-614<br>▪ Chain of transmission 491<br>▪ Common nosocomial infection 503<br>✓ Urinary tract infections 552-553<br>✓ Surgical site infections 493<br>✓ Lower respiratory infections 543-548<br>✓ Bacteremia 496-497<br>▪ Control of nosocomial infection 504 |
| 3hrs | 11 | Common disinfectants being used in hospitals in Bangladesh and how they work |

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|---|---|---|
| 4hrs | 12 | Identification of microorganisms Microscopy<br>Cultures of microorganisms<br>▪ Basic principle 276<br>▪ Media 274-284<br>▪ Culture techniques 276<br>Examination of human specimens 276-280, 596-600<br>▪ Swabs (nose, throat, cervix, ulcers and wounds) 278-280, 596-600<br>▪ Sputum 279<br>▪ Stool 278-280, 598-599<br>▪ Urine 278, 599-600 |
| Lab-4hrs | | Preparation, collection and examination of human specimens |

## B.Sc. in Nursing (Post basic)
## Microbiology and Pathology

| Units | Content & Page | Hours |
|---|---|---|
| 1 | Revision of microbiology and parasitology<br>▪ History of microbiology-12-14<br>▪ Classification of microorganism 22-23<br>▪ Prokaryotic and eukaryotic cells 22-23<br>▪ Characteristics and difference of Prokaryotic and eukaryotic cells 22-23 | 2 |
| 2 | 2.1 Bacteriology-Bacteria: 29-140<br>▪ Morphological classification 29-30<br>▪ Morphology 30<br>▪ General properties. 31<br>▪ Structure-Essential and non-essential component 30 | 2 |
| | **2.2** Bacteriology: Bacterial structure:<br>❖ Essential components- 30-38<br>▪ Cell wall. 31-33<br>▪ Cytoplasmic membrane 35-36<br>▪ Mesosome 36-37<br>▪ Cytoplasm. 36<br>▪ Ribosome. 37<br>▪ Granules. 37<br>▪ Nucleoid. 37-38 | 4 |
| 2 | 2.3 Bacteriology: Bacterial structure:<br>❖ Non-essential components-39-41<br>▪ Capsule 38<br>▪ Fimbria 39-40<br>▪ Flagella 40<br>▪ Spores. 40<br>▪ Slime layer 41 | **2** |
| | 2.4 Bacteriology- Bacterial-<br>▪ Toxin & toxoid 499-501<br>▪ Different between Endotoxin and Exotoxin 500<br>▪ Different between Toxin & Toxoid. 501 | **2** |
| | 2.5 Bacteriology-<br>▪ Bacterial growth and multiplication. 42-43<br>▪ Physical and chemical requirements. 42-43<br>▪ Bacteria growth curve.123-125 | 4 |
| | 2.6 Bacteriology-Bacterial culture mediae-<br>▪ Classification. 274 | 2 |

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| | | |
|---|---|---|
| | ▪ Description different types 274-275 | |
| 3 | **Virology:** Virus-153-254<br>▪ Definition 154<br>▪ General properties. 156<br>▪ Different parts of virus/ viral structure. 157<br>▪ Different between virus and bacteria 256<br>▪ Classification. 155<br>▪ Principal types of pathogenic virus and diseases. 155 | **2** |
| 4 | Mycology: Fungus: 409-426<br>▪ Morphological classification. 410<br>▪ General characteristics. 411<br>▪ Important fungal diseases with their causative organism. 422 | **2** |
| 5 | 5.1 Parasitology: Parasite-292-408<br>▪ Classify.293<br>▪ Host & its classification.287<br>▪ Association between host and parasite. 300<br>▪ Different between host and parasite 300 | **2** |
| | **5.3** Parasitology: **Metazoa-(Helminth) 339-394**<br>▪ Definition.339<br>▪ Classification of Helminths. 339<br>▪ General characteristics of Helminthes. 339<br>▪ Nematodes. 373-394<br>▪ Life cycle of Ascaris Lumbricoides.375-378<br>▪ Life cycle of Ancylostoma Duodenale.378-380 | **2** |
| **6** | **Immunology -Immunity-427--484**<br>▪ Definition. 428-429<br>▪ Classification 429-430<br>▪ Different between active immunity and passive immunity. 437<br>▪ Antigen and antibody. 442, 445<br>▪ Immunization Schedule in Bangladesh. 479 | **2** |
| 7. | ❖ **Pathology 566-604**<br>▪ Definition of pathology 566, Cellular response to injury 569, Causes of cell injury 568-569, Types of cell injury 569<br>▪ Cellular adaption 569, Hyperplasia 569-570, Hypertrophy 570-571, Atrophy 571, Metaplasia 571<br>▪ Definition of inflammation 571-572, Causes of inflammation 572, Types of inflammation 572, Events of inflamation 572<br>▪ Definition of edema 572-573, hemorrhage 573-574, shock 574-575, ischemic 575, infarction 577, thrombosis 575-576, and embolism 576<br>▪ Definition of neoplasms 472-473, benign and malignant neoplasm 472-473, factors causing neoplasm 474<br>▪ Collection of urine for routine, chemical and microscopic examination 599-600<br>▪ Collection of stool for routine, chemical and microscopic examination 598-599<br>▪ Total count of RBC, WBC, Platelet, differential count of WBC, Circulating eosinophil count malaria parasite 580-582, 584<br>▪ Study and morphology of RBC, WBC, Estimation of Hb% (Shali's & Cyan meth hemoglobin methods 580-590<br>▪ Description of different Anemia 594, Jaundice 594-596 and Leukemia 587 | **6** |

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| | ▪ Blood grouping and Rh factors Cross-matching and Coom's test (Direct and indirect) 590-594 | |

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## Microbiology and Pathology
## B.Sc. in Nursing (Basic)

| Contents | Teaching learning Activity | T | L | P |
|---|---|---|---|---|
| **1. Introduction to microbiology and Pathology:**<br>▪ Scope of microbiology-10, and pathology-567<br>▪ History of microbiology today: 12-14<br>▪ Chemotherapy 17<br>▪ Immunology 427-484<br>▪ Virology 153-254<br>▪ Genetic engineering and genomics 18-19<br>▪ Microbes and human diseases-289-292<br>▪ Normal microbiota (flora)- 19-20<br>▪ Infectious diseases 498-499<br>▪ Emerging infectious diseases- 501-502 (HIV/AIDS 170-174, Covid -19 230-233, Ebola 238-240 , Dengue hemorrhagic fever 223-229, Anthrax 77-78, Nipa virus 242-243, etc.) | Lecture and discussion | 6 | | |
| 2. Nature, reproduction, growth, and transmission of common micro organisms and parasites in Bangladesh<br>**Bacteria**:<br>❖ Cocci 44-62<br>▪ Diplococci (Pneumonia-48-50, Gonorrhea 57-59)<br>▪ Streptococci (Throat infection 539, Rheumatic fever-513)<br>▪ Staphylococci (Wound -493 and skin infection- 549)<br>❖ Bacilli: 63-117<br>❖ Gram positive (Tetanus 65-69, Botulism 69-72, Anthrax 77-79 )<br>▪ Gram negative (E. Coli 108-109, Shigella 101-104 and Salmonella 92-98, Gastrointestinal infection 524-531)<br>▪ Acid fast (Tuberculosis 80-87, Leprosy 87-92<br>❖ Spiral form:<br>▪ Spirochetes (Syphilis 117-121, Hemorrhagic jaundice 595-596)<br>❖ Coma :<br>▪ Vibrio (Cholera) 110-111, Helicobacter pylori (Peptic ulcer) 111-116 | Lecture and discussion<br>Group Work and presentation<br>Lab Practice | 10 | 6 | |
| 3. Viruses:<br>❖ Pneumotropic (viral pneumonia 545-547, influenza 164-168),<br>❖ Neorotropic (Viral encephalitis 520-521, Polio 195-200, Rabies 221-222)<br>❖ Viscerotropic (Infectious hepatitis 244-253, Dengue fever 222-230, Yellow fever 240-242)<br>❖ Dermatropic (Measles 176-179, Chicken Pox 207-211, Warts 214-216)<br>❖ HIV and AIDS 170-174, Covid-19 230-233 | Lecture and discussion<br>Group Work and presentation | 8 | | |
| 4. Fungi: 409-426<br>▪ Dermatophyte: Tineas or ring worms 412-413<br>▪ Candida: Candidiasis (Thrush) 418-420 | Lecture and discussion<br>Group Work and | 6 | | |

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|---|---|---|---|---|
| ▪ Cryptococcus, Cryptococosis 420-421<br>▪ Mycosis 412-421 | presentation | | | |
| 5. Parasites: Protozoa and Helminths: 302-394<br>▪ Plasmodium falciparum, vivax, ovale, malariae (Malaria) 325-332<br>▪ Leishmaniadovani (kala-azar or dumdum fever) 332-338<br>▪ Entamoebahistolytica (amoebic dysentery) 304<br>▪ Tapeworms, pinworms, hookworms, and roundworms 339-399<br>▪ Trichomonas vaginalis (trichomoniasis) 321-324<br>▪ Giardia 309-314<br>▪ Secondary parasitic infections in HIV/AIDS 338 | Lecture and discussion<br>Group Work and presentation | 6 | | |
| 6. Microorganisms and human diseases: 289-292<br>Capabilities of a pathogen<br>▪ Maintaining reservoirs: Human/animal 290<br>▪ Getting and entering the host 290<br>▪ Adhering to a body surface 290<br>▪ Evading the body 290-291<br>▪ Evading the body's defense 290-291<br>▪ Multiplying in the host 291<br>▪ Leaving the body 291 | Lecture and discussion<br>Group Work and presentation | 6 | | |
| 7. Immune system:427-484<br>▪ Adaptive immunity 434-438<br>▪ Immunological disorders 448<br>▪ Hypersensitivity 458-460<br>▪ Immunosuppression 470 | Lecture and discussion<br>Group Work and presentation | 4 | | |
| 8. Prevention and controlling of microorganisms<br>▪ Universal precautions 506-508 | Lecture & discussion<br>Lab Practice | 2 | | |
| 9. Hospital-Acquired Infection (Nosocomial infection) 502--506<br>▪ Microorganisms in the hospitals 503<br>▪ Compromised host 513-514<br>▪ Chain of transmission 491<br>▪ Common nosocomial infection 503<br>▪ Urinary tract infections 552-553<br>▪ Surgical site infections 493<br>▪ Lower respiratory infections 543-548<br>▪ Bacteremia 496-497<br>▪ Control of nosocomial infection 504 | Lecture and discussion<br>Group Work and presentation | 4 | | |
| 10. Controlling of microbial growth: 601-614<br>❖ Actions of microbial control agents 602-603<br>▪ Alterations of membrane permeability 603<br>▪ Damage to proteins and nucleic acids 603-604<br>❖ Physical methods: 604-611<br>▪ Heat: autoclave, moist, 606-610<br>▪ Pasteurization, flaming 610<br>▪ Filtration 612<br>▪ Osmotic pressure 611<br>▪ Radiation 610<br>❖ Chemical methods 611-612<br>▪ Effective disinfection and Disinfectant 604-605 | Lecture and Discussion.<br>Group Work and presentation and Lab practice | 6 | 8 | |

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| 11. Immunization: 477-483<br>▪ Active immunization 477<br>▪ Passive immunization 477-478 | Lecture & discussion<br>Group Work and presentation | 4 | | |
| 12. Identification of microorganisms<br>❖ Microscopy: Light microscopy 15-17<br>❖ Methods for light microscopic examination:<br>▪ Preparing smears for staining-281<br>▪ Simple stains-281-282<br>▪ Differential stains (gram stain, acid-fast stain) 282-284<br>❖ Cultures of microorganisms:<br>▪ Basic principles 276<br>▪ Media 274<br>▪ Culture techniques 276<br>❖ Microbiological Examination of human specimens 276-280, 596-600<br>▪ Swabs (nose, throat, cervix, ulcers, and wounds) Sputum 279<br>▪ Stool 279-280, 598-599<br>▪ Urine 278, 599-600 | Lecture and discussion<br>Group Work and presentation<br>Lab practice | 8 | 4 | |
| 13. Pathology 566-604<br>❖ General Pathology: 566-604<br>▪ Introduction to Pathology 566<br>▪ Importance of study Pathology for nurses. 567<br>▪ Cellular injury: Causes 568, types 569<br>▪ Pathogenesis 568, Immuno-pathogenesis 568<br>▪ Filtration & Regeneration 579<br>▪ Cellular Adaptation, Hyperplasia, 569-570<br>▪ Hypertrophy 570-571, Atrophy Metaplasia 571<br>▪ Edema 573-574. Ischemia 575, infarction 577-578, thrombosis 575-576 and embolism 575<br>▪ Neoplasia 472, benign and malignant neoplasm 472-474, Factors causing neoplasm 473.<br>▪ Nurse's role in assisting & preparing the patient for different diagnostic tests (Liver Function Test, Renal Function Test, OGTT, Lipid Profile, Pancreatic Function, Electrolyte, Histological, Cytological, fluid & Electrolyte balance) & understanding tests results. 578<br>❖ Clinical Pathology: 580-600<br>▪ Pathological examination: Urine 599-600, Stool 598-599, Body fluid 597-600<br>▪ Blood Test: CBC-592, ESR 592, bleeding time 582, Clotting time 583, Prothrombin time 582<br>▪ Blood Sugar Malaria parasite 585<br>▪ Blood grouping & Cross matching 590-594<br>▪ Pregnancy test 583 | Lecture and discussion<br>Group Work and presentation<br>Lab practice | 10 | 6 | |

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# Section-A
# Chapter-1

| | |
|---|---|
| ▪ Introduction to microbiology | ▪ History of Microbiology |
| ▪ Scope of Microbiology | ▪ Pioneers of microbiology |
| ▪ Scopes of parasitology | ▪ Importance of Microbiology |
| ▪ Future of Microbiology | ▪ Importance of Microbiology in Nursing |

## Introduction of microbiology:

Microbiology is the study of microorganisms, such as, bacteria, virus, fungi, protozoa and helminths that infect humans, the diseases for which they are responsible, and the diagnosis, clinical features, predisposing factors, prevention and treatment etc. of such diseases. It also discusses the response of the human host to microbes and their antigens and sometimes immunogen. Microorganisms are found abundantly almost everywhere in the environment, from mountaintops to the ocean bed. They have a closes concern with humans and sometimes animals or insects in that some parts the human body while others cause disease. A large proportion of microbes resident in human gut, skin, nose, mouth, ear, etc. which exists as normal flora, and shelter their host required for a healthy life.

*[Ref- Paniker`s, 11th Edi., p.1]*

**Introduction to Parasitology:** Parasitology is a branch of medical science that studies parasites responsible for causing diseases in humans. It primarily focuses on understanding their life cycles, transmission, and interaction with the human host. Medical parasitology is broadly divided into two main branches—Protozoology, which deals with protozoa, and Helminthology, which focuses on helminths or worms. The history of parasitology dates back to the 17th century, when Antony van Leeuwenhoek (1681) first observed *Giardia* using a single-lens microscope. Later, significant contributions were made by Louis Pasteur (1870), who studied protozoal diseases in silkworms; Patrick Manson (1878), who discovered the mosquito's role in transmitting filariasis; Alphonse Laveran (1880), who identified the malarial parasite; and Ronald Ross (1897), who proved that mosquitoes transmit malaria. By the mid-20th century, the discovery of antiparasitic drugs and the development of vector control measures greatly improved the management of parasitic diseases. Parasites are organisms that depend on a host for their survival, growth, and reproduction, often causing harm to the host in the process.

*[Ref.: Paniker's, Medical Parasitology, 9th ed., p. 3]*

## Scope of Microbiology and Parasitology

Q. Describe the scope of microbiology?

**Scope of Microbiology:** Microbiology deals with the study of microscopic organisms like bacteria, viruses, fungi, protozoa, and algae. The scope of microbiology is vast and includes several important fields:

1) **Medical Microbiology**: Study of disease-causing microbes and their roles in diagnosis, prevention, and treatment of infections.
2) **Industrial Microbiology**: Use of microorganisms in the production of products such as antibiotics, enzymes, alcohols, and organic acids.
3) **Food and Dairy Microbiology**: Application of microbes in food preservation, fermentation, and ensuring food safety.
4) **Agricultural Microbiology**: Role of microbes in soil fertility, plant health, and biological pest control.
5) **Environmental Microbiology**: Contribution of microbes in biodegradation, waste management, and pollution control.
6) **Microbial Genetics and Biotechnology**: Study of genetic manipulation of microbes for advances in medicine, agriculture, and industry.

7) **Public Health Microbiology**: Surveillance and control of infectious diseases at the community level.

Q. Explain the scope of parasitology?

**Scope of Parasitology**: Parasitology is the study of parasites, their hosts, and the relationship between them. Its scope includes:

1) **Medical Parasitology**: Study of parasites that cause human diseases, e.g., malaria (Plasmodium spp.), amoebiasis (Entamoeba histolytica).
2) **Veterinary Parasitology**: Study of parasites affecting animals and livestock, ensuring animal health and productivity.
3) **Ecological and Evolutionary Parasitology**: Study of parasite ecology and evolution, including how parasites affect host populations and ecosystems.
4) **Structural and Functional Parasitology**: Study of morphology, life cycle, physiology, and biochemistry of parasites.
5) **Parasitic Immunology**: Understanding host immune response against parasites for developing vaccines and treatments.
6) **Control and Prevention**: Researching on controlling parasites through drugs, public health strategies, and education.

*[Ref.: Jawetz, 27th ed., pp. 1–4; Paniker's, 11th ed., pp. 1–3; Sastry, 2nd ed., pp. 1–2]*

# Future of Microbiology:

Q: Briefly discuss the future trends in microbiology.

**Answer:**

1) **Detection of new diseases** – Microbiologists will play a vital role in identifying and controlling newly emerging viruses, bacteria, and fungi.
2) **Combating antibiotic resistance** – As bacteria become resistant to existing antibiotics, new drugs and treatment strategies will be essential.
3) **Advanced vaccine development** – Quicker and vaccines that are more effective will be developed to respond to emerging infections, as seen with COVID-19.
4) **Biotechnology & genetic engineering** – Microbes will be used to produce medicines, treat waste, and manufacture industrial products.
5) **Microbial role in complex disease treatment** – Future research may use microbes to treat cancer and other difficult diseases.
6) **Space microbiology** – Microbiologists will study microbial behavior in space to support future space missions.
7) **Environmental applications** – Microorganisms will help in cleaning polluted environments (bioremediation) and preserving ecological balance.

*[Ref.: Paniker's 11th ed., pp. 2–3; Apurba S. Sastry, 2nd ed., pp. 2–3]*

# Importance of Microbiology:

Q: What is the importance of microbiology?

**Answer:**

1) Helps understand fundamental life processes.
2) Essential for decomposition and nutrient recycling.
3) Maintains ecological balance.
4) Crucial in diagnosing and treating infectious diseases.
5) Used in producing antibiotics, vaccines, and fermented products.
6) Enhances soil fertility and controls plant diseases in agriculture.
7) Supports biotechnology and research innovations.
8) Contributes to sustainable solutions for global challenges.

*[Ref.: Prescott et al., 6th ed., pp. 2–4]*

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Q. What are the importance of microbiology in nursing?

**Importance of Microbiology in Nursing:** Microbiology is very important in the field of nursing for several reasons:

1) **Understanding infection**: Nurses need to know how microorganisms cause infections to prevent and control the spread of diseases among patients.
2) **Sterilization and disinfection**: Knowledge of microbiology helps nurses properly sterilize equipment and maintain hygiene, preventing hospital-acquired infections (nosocomial infections).
3) **Handling specimens**: Nurses must collect and handle patient samples (like blood, urine, sputum) carefully to avoid contamination and ensure accurate diagnosis.
4) **Antibiotic use**: Nurses administer antibiotics and monitor their effects. Understanding microbial resistance helps in better patient care.
5) **Immunization:** Nurses educate patients about vaccines and often administer them. Microbiology knowledge helps explain how vaccines protect against diseases.
6) **Patient education**: Nurses teach patients about hygiene, infection prevention, and disease management, based on microbiological principles.
7) **Wound care and infection control**: In wound management, understanding bacterial contamination and infection control practices is essential.

*[Ref.: Paniker's 11th ed., pp. 2–3; Apurba Sastry 2nd ed., pp. 3–4]*

# History of Microbiology: -

The history of microbiology can be conveniently divided into three periods-

1) **The period of speculation** preceding the development of the compound microscope, from prehistoric time to 1850.
2) The "**golden age**" of microbiology when the microscopic organisms other than the **rickettsia** and the **viruses** were discovered, time 1850 to 1910 (Obligate Gram Negative bacteria found in ticks, lice, fleas, mites, chiggers and mammals.
3) **The modern period**, 1910 to present.

# The Golden Age of Bacteriology (1850-1910)

Microbiology emerged as a science in the 19th century with the invention and refinement of the microscope and staining techniques. Early on, microscopes were unreliable, but by 1835, better models began to emerge. This allowed scientists to observe microorganisms and their role in fermentation and disease. Louis Pasteur (1822-1895) and Robert Koch (1843-1910) were pioneers in this field.

- **Louis Pasteur**: A chemist who is known for developing the germ theory of disease. His studies on fermentation led to the development of vaccines for diseases like anthrax (1881) and rabies (1885). He also worked on methods to prevent spoilage in food (pasteurization).
- **Robert Koch**: A physician who discovered the causative agents of diseases like tuberculosis, cholera, and anthrax. He developed Koch's Postulates, a set of criteria to prove that a specific microorganism causes a specific disease.
- **Advancements**: The development of pure culture techniques, the invention of Petri dishes, and the use of agar as a solid medium for bacterial growth were all major advancements. In 1881, Koch developed a method to grow bacteria on solid media, which allowed for better identification and study of pathogens.

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**Key Contributions and Discoveries:**

- **The Role of Microorganisms**: Pasteur's experiments showed that microorganisms were responsible for fermentation and spoilage. He also demonstrated that diseases like silkworm disease were caused by microorganisms.
- **Vaccines and Immunity**: Pasteur's development of vaccines for anthrax and rabies laid the foundation for immunology. His work demonstrated that microorganisms could be controlled through vaccination, reducing the spread of infectious diseases.
- **Koch's Postulates**: Koch's work established a systematic approach for identifying the causative agents of diseases. He identified the tuberculosis bacterium (1882) and cholera (1883), marking critical steps in understanding infectious diseases.
- **New Microorganisms**: The discovery of rickettsia by Howard Ricketts (1906), and the understanding of viruses like yellow fever, also marked key developments in microbiology.

## Microbiology in America:

In the 1800s, microbiology was developing slowly in America compared to Europe. However, by the late 19th century, American scientists began to catch up:

- **Early American Efforts**: In 1851, Charles Spencer of Buffalo, New York, started making high-quality microscopes. In the 1880s, American biologists began studying microbiology more seriously, inspired by European advances.
- **Laboratories and Institutions**: The U.S. set up laboratories modeled after European ones. In 1887, the Massachusetts Institute of Technology established the Lawrence Experiment Station for studying water and sewage microbiology. The U.S. Public Health Service established a bacteriology laboratory, which later became the National Institute of Health.
- **Public Health Initiatives**: In 1892, during a cholera threat in New York City, municipal laboratories were created to address disease outbreaks, marking the beginning of organized microbiological research for public health.

Table 1.1:

## Pioneers of Microbiology

| Name | Birthplace | Title/Profession | Major Contributions |
|---|---|---|---|
| Louis Pasteur (1822–1895) | Dole, France | Chemist & Microbiologist | Germ theory, pasteurization, vaccines for rabies and anthrax |
| Robert Koch (1843–1910) | Clausthal, Germany | Physician & Microbiologist | Koch's postulates; discovery of tuberculosis and cholera bacteria |
| Dmitri Iwanowski (1864–1920) | Russia | Biologist | Discovered the first virus (Tobacco Mosaic Virus) |
| Martinus Beijerinck (1851–1931) | Netherlands | Microbiologist | Coined the term "virus"; proved viruses differ from bacteria |
| Joseph Lister (1827–1912) | Essex, England | Surgeon | Introduced antiseptic surgery using carbolic acid |
| Alexander Fleming (1881–1955) | Scotland | Bacteriologist | Discovered penicillin in 1928 |
| Edward Jenner (1749–1823) | Gloucestershire, England | Physician | Developed the first smallpox vaccine |
| Howard Ricketts (1871–1910) | Illinois, USA | Pathologist | Identified *Rickettsia* bacteria (spotted fever, typhus) |
| Wendell M. Stanley (1904–1971) | USA | Biochemist | Crystallized virus protein; Nobel Prize in Chemistry, 1946 |
| John Enders, Thomas Weller, Frederick Robbins | USA | Virologists | Cultivated poliovirus in tissue cultures; Nobel Prize, 1954 |

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# Modern Microbiology (1910-Present):

The 20th century saw major advancements in microbiology, especially in the study of viruses, bacteria, and genetics. The development of the electron microscope allowed for the visualization of viruses, which were previously invisible under light microscopes.

1) **Virology**: In 1892, Dmitry Iwanowski demonstrated the presence of viruses, laying the groundwork for modern virology. By 1930, Robert Woodruff and Ernest Goodpasture used chick embryos to culture viruses, and advances in filter technology made it possible to study these tiny organisms.
2) **Key Advances in Virology**: The discovery that viruses could be cultured in cell lines and chick embryos helped scientists understand their structure and behavior. The first vaccines for viral diseases like polio (developed by Jonas Salk in the 1950s) were based on this research.
3) **Nobel Prizes**: Many Nobel Prizes in the 20th century were awarded for microbiological discoveries:
    a) **Wendell M. Stanley** (1946) for purifying virus proteins.
    b) **John F. Enders, Thomas H. Weller, and Frederick C. Robbins** (1954) for developing the polio vaccine.
    c) **George W. Beadle, Edward L. Tatum, and Joshua Lederberg** (1958) for their work on the genetic control of chemical processes in microorganisms.
4) **Genetics and Biochemistry**: Studies on the genetics and biochemistry of microorganisms became increasingly important in the 20th century. Researchers like Beadle, Tatum, and Lederberg made major contributions to our understanding of heredity in microorganisms and the genetic mechanisms that govern all life.
5) **Integrated Approaches**: By the mid-20th century, microbiology was no longer seen as a separate discipline from other biological sciences. Advances in genetics, biochemistry, and molecular biology helped bridge the gap between medical microbiology and other fields of biology, making it a crucial component in the study of diseases and life processes.

*[This historical timeline of microbiology is adapted from Genevieve Gray]*

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# Chapter-2

| | |
|---|---|
| ▪ History of the Microscope,<br>▪ Type of microscope.<br>▪ Definition of microscope<br>▪ Classification of microscope<br>▪ Parts of microscope<br>▪ Microscope-Its care and use | ▪ Chemotherapy<br>▪ Genetic engineering and genomics<br>▪ Normal microbiota (flora)<br>▪ General Microbiology and Microorganism<br>▪ MCQ |

## Brief History and Development of the Microscope:

The invention of the microscope revolutionized science by allowing observation of organisms and structures invisible to the naked eye.

1) **Early Inventions (16th–17th Century)**: Dutch spectacle makers **Zacharias Janssen** and **Hans Lippershey** developed the concept of the compound microscope. In **1609**, **Galileo Galilei** improved it, producing one of the earliest functional microscopes.
2) **Advancements by Anton van Leeuwenhoek**: In the late 1600s, Dutch scientist **Leeuwenhoek** crafted powerful single-lens microscopes. He was the first to observe bacteria, protozoa, and red blood cells, earning him the title **"Father of Microbiology."**
3) **Achromatic Lens (1729)**: **Chester Moore Hall** invented the achromatic lens, reducing color distortion and significantly improving microscope clarity.
4) **Mechanical and Optical Improvements (18th–19th Century)**:
    a) **August Köhler**: Developed a method for even illumination—vital for microscopy photography.
    b) **Ernst Leitz**: Created the rotating nosepiece for multiple magnification lenses.
    c) **Ernst Abbe** (with Carl Zeiss): Enhanced image clarity and helped develop the **ultraviolet microscope**.
5) **Electron Microscopy (1931)**: Invented by Max Knoll and Ernst Ruska, the electron microscope surpassed the optical microscope's resolution, revealing ultrastructural details of cells and viruses.
6) **Scanning Probe and Atomic Force Microscopy**:
    a) **1981**: Gerd Binnig and Heinrich Rohrer invented the Scanning Tunneling Microscope (STM).
    b) **1986**: Binning and team introduced the Atomic Force Microscope (AFM), opening doors for nanotechnology.

**Types of Modern Microscopes:**

1) **Light (Optical) Microscope**: Uses lenses and visible light; magnifies up to 1,000x.
2) **Phase-Contrast Microscope**: Enhances contrast in transparent samples; ideal for viewing live cells.
3) **Fluorescence Microscope**: Uses fluorescent dyes; highlights specific cell components.
4) **Dark-Field Microscope**: Highlights unstained samples against a dark background.
5) **Differential Interference Contrast Microscope**: Reveals detailed structures and allows chemical analysis.
6) **Confocal Scanning Laser Microscope**: Produces sharp, layered images using laser light.
7) **Electron Microscope**: Includes Transmission (TEM) and Scanning (SEM); allows viewing of subcellular structures.

Q Who Invented the First Microscope?

**Answer:** The microscope was first developed by Dutch spectacle makers Zacharias Janssen and Hans Lippershey in the late 16th century. Galileo Galilei later improved it in 1609. Anton van Leeuwenhoek advanced it further and was the first to observe bacteria and protozoa.

*[Ref.: Paniker 11th ed., pp. 7–10]*

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Q. What is a microscope?

**Microscope:** A microscope is an optical instrument that is used to observe objects too small to be seen clearly with the naked eye. It magnifies tiny structures such as cells, microorganisms, and tissues, allowing scientists and students to study their shape, size, and details. Microscopes are essential tools in microbiology, biology, and medical science for understanding the microscopic world

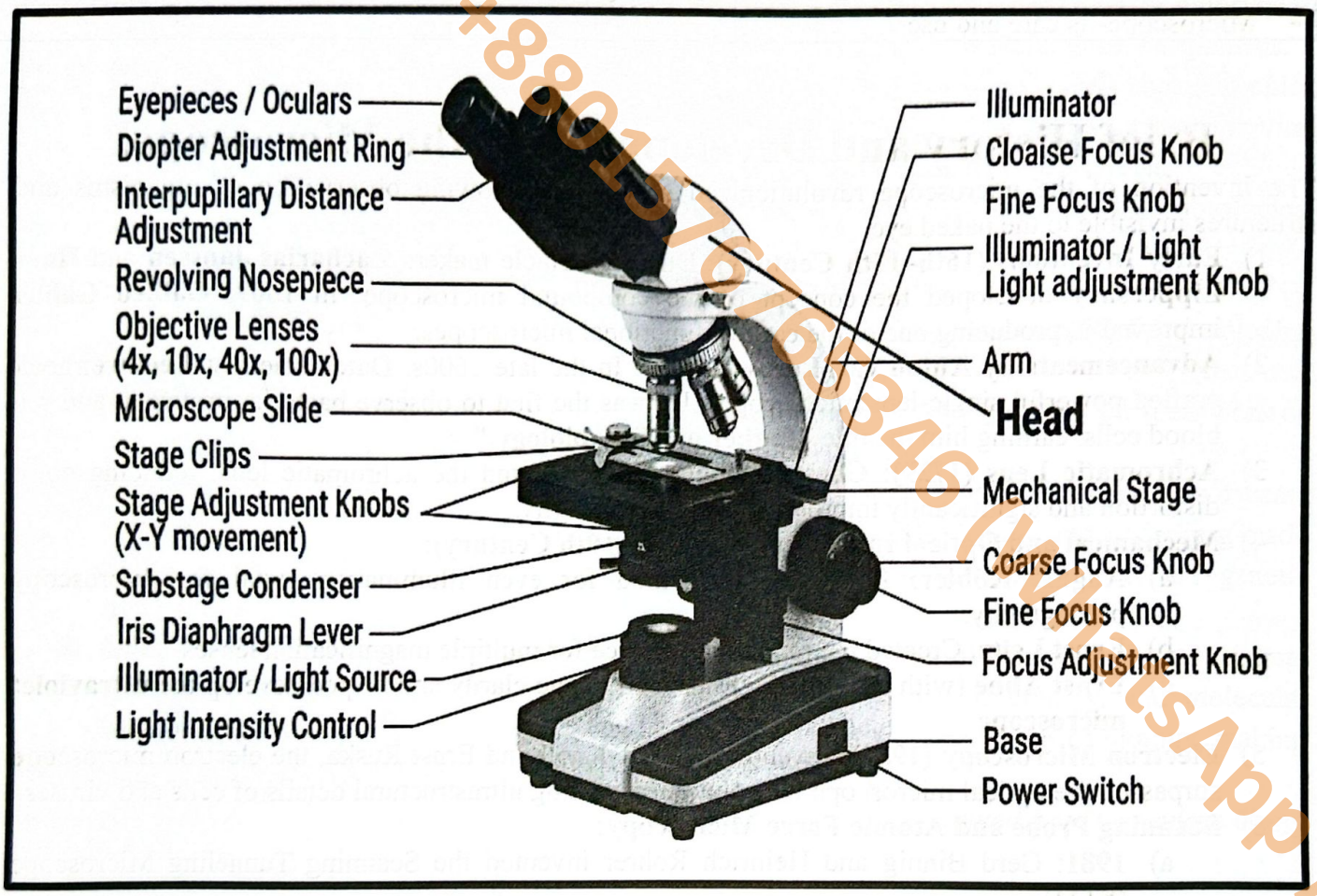


Figure-2.1 Binocular Light Microscope

Table-2.1 **Parts of the typical binocular microscope**:

| | |
|---|---|
| 1. Ocular Lenses/Eyepieces-2 | 12. Condenser-1 |
| 2. Diopter Adjustment Ring-2 | 13. Coarse Adjustment-1 |
| 3. Interpupillary Distance-1 | 14. Fine Adjustment-1 |
| 4. Head-1 | 15. Diaphragm-1 |
| 5. Revolving Nose Piece-1 | 16. Stage Control-1 |
| 6. Objective Lences-4 | 17. Focus Adjustment Knobs |
| 7. Arm-1 | 18. Illuminator (Light sources)-1 |
| 8. Mechanical stage-1 | 19. Brightness Adjustment-1 |
| 9. Stage Clip-1 | 20. Light Switch-1 |
| 10. Stage Adjustment Knobs | 21. Base-1 |
| 11. Aperture-1 | 22. Power Switch-1 |

Q. Classify microscope.

**Classification of microscope**:

1) **Depending on number of lenses**:
   a) Single microscope
   b) Compound microscope

2) **Depending on number of eyepiece**:
   a) Monocular microscope
   b) Binocular microscope
3) **Depending on sources**:
   a) Light or optical microscope
   b) Electron microscope

## Care and Maintenance of Microscope:

Q. How do we care and maintain a microscope?

1) Always carry the microscope with both hands — one hand holding the arm and the other supporting the base.
2) Clean the lenses (ocular and objectives) only with lens paper before and after use.
3) Never touch the lenses with fingers.
4) Always start focusing with the low-power objective lens before switching to high-power.
5) After use, lower the stage, rotate to low-power objective, and cover the microscope with a dust cover.
6) Keep the microscope in a dry and clean place to prevent fungal growth.
7) If the microscope is electrically powered, switch it off and unplug it after use.
8) In case of mechanical or optical problems, consult a trained technician rather than attempting to fix it yourself.

## Uses of Microscope

Q. What are the function or use of microscope?

1) **Observation of Bacteria, Viruses, and Fungi**: Essential for identifying disease-causing organisms.
2) **Study of Cell and Tissue Structures:** Important in medical diagnostics and biological research.
3) **Identification of Parasites**: For diagnosing infections like malaria and amoebiasis.
4) **Pathology Laboratories**: Examining tissue slides and blood smears for disease detection.
5) **Educational Institutions:** Teaching students about microscopic organisms and structures.
6) **Biotechnology and Research**: Used in developing new drugs, vaccines, and genetic studies.
7) **Quality Control**: Ensuring the safety and quality of food, beverages, and pharmaceuticals.

[Ref.: *Prescott* et *al., 6th ed., pp. 31–33;* Tortora *et al., 12th ed., pp. 52–54, Ch. 3]*

## Chemotherapy:

**Paul Ehrlich** introduced the concept of chemotherapy in **1910**, calling it "magic bullets" — chemicals that kill microbes without harming the host. He used **a**rsphenamines and recognized selective toxicity, drug resistance, and combined therapy. Gerhard Domagk discovered sulphonamides in 1935, marking the start of modern antimicrobial chemotherapy. Alexander Fleming discovered penicillin in 1929, and it was clinically applied by Florey and Chain in 1940. This led to the discovery of many antibiotics like tetracycline and chloramphenicol.

*[Ref.: Choudhury, 5th ed., p. 49]*

## Antimicrobial drugs/agent

Q. What is antimicrobial drugs/agent?

**Answer:** Antimicrobial drugs or agents are substances that inhibit the growth of or kill microorganisms, such as bacteria, viruses, fungi, or parasites.

*[Ref.: Sharif, 8th ed., p. 77]*

Q: What are the basic principles of antimicrobial therapy?

**Answer:**

1) **Selective toxicity** – Kills microbes without harming the host.



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2) **Target sites** – Acts on cell wall, ribosomes, nucleic acids, or membrane.
3) **Broad-spectrum antibiotics** – Active against many microbes (e.g., tetracycline).
4) **Narrow-spectrum antibiotics** – Target specific microbes (e.g., vancomycin).

*[Ref.: LANGE Review, 17th ed., p. 67]*

# Probiotics

Q. What is probiotics?
**Answer:** Probiotics are live microorganisms that, when taken in adequate amounts, provide health benefits to the host. They help inhibit harmful microbes, support the mucosal barrier, and interact with the immune system. Probiotics are commonly used to treat antibiotic-associated diarrhea.
**Examples include**:

- *Bifidobacterium*, *Lactobacillus*

*[Ref.: Paniker's, 11th ed., p. 188]*

# Genetic engineering and genomics:

**Genetic engineering**: **Genetic engineering** is a branch of biotechnology that involves the direct manipulation of an organism's genes using modern molecular biology techniques. It allows scientists to insert, delete, or modify specific genes to achieve desired traits—such as disease resistance in plants or the production of therapeutic proteins like insulin in bacteria. This technology has significant applications in medicine, agriculture, and industry.

**Genomics:** Genomics is a branch of modern biology that deals with the study of the **complete set of genes (genome)** of an organism. It focuses on analyzing the structure, function, mapping, and interaction of all genes present in the DNA. Every living organism — including humans, animals, plants, and microorganisms — has a genome that carries genetic information. Genomics helps scientists understand how genes work together, how they control body functions, and how changes in genes can cause diseases.

Q. What is genomics?
**Genomics:** The study of an organism's entire genome, including the sequencing, mapping, and analysis of genes and their functions. It focuses on understanding all genes in a genome and their interactions.

[Ref.: *Choudhury*, 5th ed., pp. 70–72; *LANGE Review*, **17th ed., pp**. 237–240]

Q. Define genetic engineering with examples.
**Definition:** Genetic engineering is the process of directly manipulating an organism's genetic material using biotechnology. It involves inserting, deleting, or altering specific genes to introduce or modify desired traits.
**Examples:**

- **Golden Rice** – engineered to produce β-carotene (a precursor of Vitamin A).
- **Bt Cotton** – modified with a gene from *Bacillus thuringiensis* to resist insect pests.

Q. What is Bt Cotton?
**Answer**: Bt Cotton is a genetically modified cotton plant that produces a toxin from the bacterium *Bacillus thuringiensis* (Bt). This toxin kills harmful insects like bollworms, reducing the need for chemical pesticides.

Q. What are the 5 steps of genetic engineering?
**Stages of genetic engineering to include:**

1) Gene Indentification and Isolation
2) Gene Cloning
3) Gene Insertion in to the Host Organism
4) Selection and Screening

5) Expression and Harvesting

*[Ref.: Watson, J.D., Molecular Biology, 7th ed.]*

Q. What are the benefits of genetic engineering?

**Some benefits of genetic engineering in agriculture are-**

1) Development of Pest-Resistant and Disease –Resistant Crops
2) Improvement of Human Health
3) Cancer Treatment
4) Control of Bacteria and Viruses
5) Improvement of Animal Species
6) Environmental Benefits
7) Production of new products and Food
8) Waste Management and Recycling
9) Industrial and Biotechnical Applications

[Ref.: *Watson, J.D., Molecular Biology*, 7th ed.]

# Normal microbiota (flora)

Q. What is normal flora?

**Normal Flora:** Normal flora refers to the various microorganisms (bacteria and fungi) that permanently reside in specific body sites, especially the skin, oropharynx, colon, and vagina.

*[Ref.: LANGE Review, 17th ed., p. 25]*

Q: Name the important sites of normal flora with examples.

**Answer:**

1) **Skin** – *Staphylococcus epidermidis*, *S. aureus*, *Candida albicans*
2) **Oropharynx** – *Streptococcus sanguinis*, *S. mutans* (viridans group)
3) **Gastrointestinal tract** – *Bacteroides fragilis*, *E. coli*, *Enterococcus faecalis*
4) **Vagina** – *Lactobacilli* (maintain low pH)
5) **Urethra** – *S. epidermidis*, *E. coli* (may cause UTI)

*[Ref.: LANGE Review, 7th ed., pp. 28–29]*

Q. Mention ten (10) characteristics of normal flora.

Characteristics of Normal Flora:

1) Naturally present on skin and mucous membranes.
2) Found in mouth, intestine, respiratory tract, and genital tract.
3) Normally non-pathogenic in healthy individuals.
4) Live in commensal or symbiotic relationship with host.
5) Protect against pathogenic microorganisms.
6) Help in development of immune system.
7) Some synthesize vitamins (e.g., Vitamin K, B-complex).
8) Compete for nutrients and attachment sites.
9) May cause opportunistic infection if immunity decreases.
10) Composition varies with age, diet, environment, and hygiene.

Q. Write down the beneficial & harmful effects of normal flora.

**Beneficial effects of normal flora (Role in health maintenance):**

1) **Prevention of Colonization of Pathogens:** Normal flora competes with invading pathogens for nutrients and receptor sites, thereby preventing infections in areas such as the mouth, intestine, and lower bowel.
2) **Production of Antimicrobial Substances:** Certain bacteria produce bacteriocins and other inhibitory substances that suppress the growth of pathogenic organisms.

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3) **Antigenic Stimulation:** In newborns, normal flora stimulates the development of the immune system, especially promoting the production of secretory Immunoglobulin A (IgA), which provides mucosal protection.
4) **Nutritional Function:** Intestinal bacteria synthesize essential nutrients such as vitamin K and some B-complex vitamins, and also assist in digestion and nutrient absorption.

**Harmful effects of normal flora (Role in disease causation):**

1) **Displacement to Abnormal Sites:** If normal flora enters normally sterile areas (e.g., skin flora entering the bloodstream or urinary tract), it may cause serious infections such as septicemia, urinary tract infection, or bacterial endocarditis (e.g., *Staphylococcus*, *Streptococcus*).
2) **Carcinogenic Transformation:** Some normal flora may metabolize dietary substances into potentially carcinogenic compounds in the colon.
3) **Opportunistic Infections in Immunosuppression:** When host immunity is suppressed (due to disease, chemotherapy, or prolonged antibiotic therapy), normal flora may overgrow and cause infections (e.g., *Candida albicans* causing candidiasis, *Clostridioides difficile* causing pseudomembranous colitis).

*[Ref.: Lippincott*, 2nd ed., p. 10]

Q: Give some examples of normal flora with their sites.

**Answer:** Normal flora refers to the microorganisms that naturally live on or in various parts of the human body without causing disease. The table below shows some examples of normal flora and their typical sites:

Table 2.2 Examples of Normal Flora with Their Sites

| Location | Important Organisms | Less Important Organisms |
|---|---|---|
| Skin | *Staphylococcus epidermidis*, *Corynebacterium*, *Propionibacterium* | *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Candida albicans* |
| Nose | *Staphylococcus aureus* | *Staphylococcus epidermidis* |
| Mouth | *Viridans streptococci* | Various *Streptococcus* species |
| Throat | *Viridans streptococci*, *Streptococcus pneumoniae*, *Staphylococcus epidermidis*, *Haemophilus influenzae* | *Streptococcus pyogenes* |
| Colon (Intestine) | *Escherichia coli*, *Bacteroides fragilis* | *Bifidobacterium*, *Eubacterium*, *Fusobacterium*, *Lactobacillus*, *Enterococcus faecalis* |
| Vagina | *Lactobacillus*, *Escherichia coli*, Group B *Streptococci* | *Corynebacterium*, *Candida albicans*, *Bacteroides fragilis* |
| Urethra | *Corynebacterium*, *Staphylococcus epidermidis*, *Escherichia coli* | – |

*[Ref.: LANGE Review, Microbiology, 11th ed., p. 26]*

Q. Name the sterile area of the body

**Answer:**

1) **Respiratory tract**: larynx, trachea, bronchi, bronchioles, alveoli
2) Blood and cerebrospinal fluid (CSF)
3) **Gastrointestinal tract**: esophagus, liver, gall bladder, peritoneum
4) **Serous cavities**: synovial, pleura, pericardium, meninges
5) Deep tissues

*[Ref.: M.R. Choudhury, 5th ed., p. 90]*

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# Microbiology

Q. Define microbiology

**Microbiology:** The words' microbiology derives from three separates words: micro-small, bios-life, logos-knowledge. Microbiology is, "the science that deals with the study of small living organisms either microscopic or submicroscopic creatures".

[Ref.: *Sharif, 8th ed., p. 2*]

Q: What are the branches of medical microbiology?

The main branches of medical microbiology are:

1) **Bacteriology**: Studies bacteria, their structure, diseases, pathogenesis, diagnosis, and treatment.
2) **Virology**: Focuses on viruses, their structure, diseases, pathogenesis, diagnosis, and treatment.
3) **Mycology**: Examines fungi, their structure, diseases, pathogenesis, diagnosis, and treatment.
4) **Parasitology**: Studies medically important parasites, such as protozoa and helminths.
5) **Immunology**: Focuses on the host's immune response to microorganisms.
6) **Clinical microbiology**: Deals with organ-specific microbial diseases.

*[Ref: Sharif, 8th edition, p.2]*

Q What are the branch of microbiology?

The branches of microbiology can be classified into two main categories: **Pure Microbiology** and **Applied Microbiology**.

**A. Pure Microbiology:**

1) **Bacteriology**: Study of bacteria
2) **Mycology**: Study of fungi
3) **Protozoology**: Study of protozoa
4) **Phycology/Algology**: Study of algae
5) **Parasitology**: Study of parasites
6) **Immunology**: Study of the immune system
7) **Virology**: Study of viruses
8) **Nematology**: Study of nematodes
9) **Microbial Cytology**: Study of microscopic and submicroscopic details of microorganisms
10) **Microbial Physiology**: Study of microbial cell functions and biochemistry
11) **Microbial Pathogenesis**: Study of pathogens caused by microbes
12) **Microbial Ecology**: Study of microorganisms and their environment
13) **Microbial Genetics**: Study of genes and their regulation in microbes
14) **Cellular Microbiology**: A discipline bridging microbiology and cell biology
15) **Evolutionary Microbiology**: Study of microbial evolution
16) **Generation Microbiology**: Study of microorganisms with identical characteristics as their parents
17) **Systems Microbiology**: Bridging systems biology and microbiology
18) **Molecular Microbiology**: Study of molecular principles of microbial processes

**B. Applied Microbiology:**

1) **Medical Microbiology**: Study of pathogenic microbes and their role in human illness
2) **Pharmaceutical Microbiology**: Study of microorganisms related to pharmaceuticals
3) **Industrial Microbiology**: Exploitation of microbes in industrial processes
4) **Microbial Biotechnology**: Genetic manipulation of microbes to create useful products
5) **Food Microbiology**: Study of microorganisms causing food spoilage and illness
6) **Agricultural Microbiology**: Study of microorganisms in agriculture
   - **Plant Microbiology & Plant Pathology**: Microorganisms' interaction with plants
   - **Soil Microbiology**: Microorganisms found in soil
7) **Veterinary Microbiology**: Study of microbes in veterinary medicine
8) **Environmental Microbiology**: Study of microorganisms in natural environments
9) **Water Microbiology (Aquatic Microbiology)**: Study of microorganisms in water
10) **Aero Microbiology (Air Microbiology)**: Study of airborne microorganisms

[Ref.: *Paniker's Microbiology*, 11th ed., pp. 15–18]

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# Chapter: 5

| Gram Positive Bacillus | Mycobacterium |
|---|---|
| **Clostridium:** | ▪ Mycobacterium Tuberculosis |
| ▪ Clostridium Tetani | ▪ Mycobacterium Leprae |
| ▪ Clostridium Botulinum | **Gram Negative Bacillus** |
| ▪ Cl. Perfringens | ▪ Salmonella & Shigella |
| **Corynebacterium:** | ▪ Kliebsiella & Proteus |
| ▪ Corynebacterium Diphtheriae | ▪ Pseudomonas |
| ▪ Bacillus Anthraces | ▪ Escherichia coli |
| ▪ Gas Gangrene | ▪ Vibrio cholera |
| ▪ Food poisoning | ▪ Helicobacter pylori |
| | ▪ Campylobacter jejuni & Peptic ulcer |

## Bacillus

Q: Classify Bacilli with example

**Answer:** Bacilli can be classified based on their Gram-staining and oxygen requirements:

1) **Gram-Positive Bacilli:**
   - *a) **Aerobic Bacilli:***
     - *Corynebacterium diphtheriae*
     - *Bacillus anthracis* (Anthrax bacillus)
   - *b) **Anaerobic Bacilli:***
     - *Clostridium tetani*
     - *Clostridium botulinum*
2) **Gram-Negative Bacilli:**
   - *Salmonella* spp.
   - *Shigella* spp.
   - *Escherichia coli*
   - *Vibrio cholerae*
   - *Klebsiella* spp.
   - *Proteus* spp.
   - *Pseudomonas* spp.

*[Ref: Paniker's, 11th ed., p. 232]*

## Gram Positive Rods (Bacilli)

Q: Classify Gram-positive rods with examples.

**Answer:** Gram-positive rods (bacilli) are classified based on oxygen requirement and spore formation:

A. **Aerobic Gram-Positive Rods:**
   1) **Spore-forming Bacilli:**
      - *Sporosarcina*
      - *Paenisporosarcina*
      - *Peribacillus*
      - *Geobacillus*
   2) **Non–spore-forming Bacilli:**
      - *Corynebacterium & Listeria*

B. **Anaerobic Gram-Positive Rods:**
   1) **Spore-forming Bacilli:** Clostridium
   2) **Non–spore-forming Bacilli:**
      - *Actinomyces*
      - *Nocardia*
      - *Lactobacillus*
      - *Bifidobacterium*
      - *Eubacterium*
      - *Propionibacterium*

*[Ref: LANGE, 17th ed., p. 130]*

# Clostridium

Q. Name the important species of clostridium.

**Four species of *Clostridium* are of significant medical importance:**

1) *Clostridium tetani*
2) *Clostridium botulinum*
3) *Clostridium perfringens* (causes gas gangrene or food poisoning)
4) *Clostridium difficile*

All *Clostridium* species are anaerobic, spore-forming, and Gram-positive rods.

*[Ref: LANGE, 17th ed., p. 132]*

**Morphology of *Clostridium***

1) Gram-positive bacilli
2) Non-acid fast
3) Rod-shaped with rounded ends
4) **Spore-forming**: Spherical, terminal spores larger than the bacillary body
5) **Motile**: With peritrichous flagella
6) Non-capsulated
7) Cultured anaerobically on blood agar

*[Ref: LANGE, 17th ed., p. 132; Choudhury, 5th ed., p. 265]*

Q: Classify ***Clostridium*** with examples.

**Answer:** *Clostridium* can be classified in two main ways: by the position and shape of the spores **and** by their biochemical properties.

**A. Classification Based on Position and Shape of Spores:**

1) **Oval Sub-terminal Spores:**
   - *Clostridium perfringens*
   - *Clostridium septicum*
   - *Clostridium botulinum*
2) **Oval Terminal Spores:**
   - *Clostridium tetani*
3) **Spherical Terminal Spores:**
   - *Clostridium tetanomorphum*

**B. Classification Based on Biochemical Properties**

1) **Predominantly Proteolytic & Mildly Saccharolytic**
   (Proteolytic ++ and Saccharolytic ±)
2) **Predominantly Saccharolytic & Mildly Proteolytic**
   (Saccharolytic ++ and Proteolytic ±)
3) **Mildly Proteolytic, Not Saccharolytic**
   (Proteolytic ± and Saccharolytic -)
4) **Mainly Saccharolytic, Not Proteolytic**
   (Saccharolytic ++ and Proteolytic -)
5) **Neither Proteolytic Nor Saccharolytic**
   (Proteolytic - and Saccharolytic -)

*[Ref: CHOUDHURY M.R., 5th ed., pp. 264-265]*

Q: Enumerate anaerobic spore-forming bacteria and the diseases they cause.

**Answer:** Medically important anaerobic spore-forming bacteria of the *Clostridium* group and the diseases they cause:

1) **Clostridium tetani** – Tetanus
2) **Clostridium botulinum** – Botulism
3) **Clostridium perfringens** – Gas Gangrene
4) **Clostridium difficile** – Antibiotic-associated Pseudomembranous Colitis
5) **Clostridium septicum** – Sepsis

*[Ref: Choudhury. 5th ed., p. 264]*



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Q: List the medically important *Clostridia* and the diseases they produce.
**Answer:** The medically significant *Clostridia* species and their associated diseases include:

1) **Clostridium tetani** – Causes **Tetanus**
2) **Clostridium botulinum** – Causes **Botulism**
3) **Clostridium perfringens** – Causes Gas Gangrene (Histotoxic)
4) **Clostridium difficile** – Causes **Antibiotic-associated Pseudomembranous Colitis**
5) **Clostridium septicum** – Causes Sepsis (Histotoxic)

*[Ref: CHOUDHURY MR., 5th ed., p. 264]*

# Clostridium Tetani

Q: How is *Clostridium tetani* transmitted?
**Answer:** *Clostridium tetani* is transmitted through:

1) **Entry of spores into wounds**, especially deep, dirty, or puncture wounds.
2) **Contamination with soil, dust, or animal feces** containing spores.
3) **Non-sterile medical or surgical procedures** (rare cases).
4) **Skin-popping**, a technique where drug addicts inject drugs into the skin.
5) **Germination of spores** is facilitated by necrotic tissue and poor blood supply in the wound.
6) **Neonatal tetanus** can occur when the organism enters through a contaminated umbilicus or circumcision wound, particularly in developing countries.
7) **No person-to-person spread** occurs.

*[Ref: LANGE, 17th ed., p. 133]*

Q: Write down the morphology of *Clostridium tetani*.
**Answer:**

1) Slender bacillus, Gram-positive, Non-acid fast, Non-capsulated
2) Motile and Spore-forming
3) Anaerobic
4) **Toxin**: Exotoxin
5) **Disease**: Tetanus
6) **Incubation period**: 6-12 days

*[Ref: Paniker's, 11th ed., p. 249]*

# Tetanus

**Prevalence:** Tetanus is globally distributed, though the incidence has decreased significantly due to preventive measures. However, its prevalence remains high in Bangladesh. In Comilla district, 8% of deaths were attributed to tetanus. Neonatal tetanus, locally called Takuria, is responsible for 10% of deaths in children under one year in the country.

*[Ref: CHOUDHURY, 5th ed., p. 264]*

Q. Name the causative agent of tetanus
**Answer**: Causative agent of tetanus- Clostridium tetani

Q. Write down the pathogenesis of Tetanus.
**Answer:**

1) **Organism**: *Clostridium tetani* – spore-forming, anaerobic bacillus found in soil.
2) **Entry**: Spores enter the body through wounds (e.g., deep cut, burn, surgical site, umbilical stump).
3) **Germination**: In anaerobic conditions of damaged tissue, spores germinate into vegetative cells.
4) **Toxin production**: Bacteria multiply and release tetanospasmin (neurotoxin).
5) **Absorption**: Toxin enters motor nerve endings at the site.
6) **Transport**: Toxin travels retrogradely along peripheral nerves to the spinal cord and brainstem.
7) **Action**:
   - Binds to ganglioside receptors.
   - Blocks release of inhibitory neurotransmitters (e.g., glycine, GABA) at synapses.
8) **Effect**: Loss of inhibition → muscle overactivity, leading to:



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- Muscle rigidity
- Painful spasms
- Lockjaw (trismus)
- Hyperreflexia

*[Ref: LANGE 17th ed. p. 133; Sharif 8th ed. p. 220]*

Q. What are the risk factors for tetanus?

**Major Risk Factors:**

1) **Lack of immunization or incomplete vaccination** (most important risk factor)
2) **Puncture wounds** (nails, needles, splinters)
3) **Contaminated wounds** (soil, dust, manure → *contains C. tetani spores*)
4) **Deep or dirty wounds with devitalized tissue**
5) **Crush injuries**
6) **Burns (especially deep burns)**

**Moderate Risk Factors**:

1) **Surgical wounds** (if aseptic technique is poor)
2) **Animal bites**
3) **Chronic wounds** (ulcers, gangrene, diabetic foot wounds)

**Special Situations**:

1) **Umbilical stump infection in newborns**
2) **Injection drug use** (sharing or re-using contaminated needles)

*[Ref: LANGE, 17th ed., p. 133]*

Q. Write a short note on tetanus.

**Short Note on Tetanus:**

1) **Definition:** Tetanus is an acute, life-threatening disease caused by *Clostridium tetani* producing the neurotoxin tetanospasmin, leading to severe muscle spasms.
2) **Cause:** Tetanus is caused by Clostridium tetani, an anaerobic, spore-forming gram-positive bacillus. It produces a potent exotoxin called tetanospasmin.
3) **Types of Tetanus:**
   a) **Generalized tetanus** (most common)
   b) **Localized tetanus**
   c) **Cephalic tetanus**
   d) **Neonatal tetanus (Takuria)**
4) **Pathogenesis:** Tetanospasmin travels via peripheral nerves to the CNS and blocks inhibitory neurotransmitters (GABA, glycine), causing uncontrolled muscle contractions and spasms.
5) **Symptoms:**
   a) **Trismus (lockjaw)** — spasm of masseter muscles
   b) **Generalized muscle rigidity**
   c) **Opisthotonus** (arched back due to severe spasm)
   d) **Difficulty swallowing** (dysphagia)
   e) **Respiratory muscle spasm** → breathing difficulty
6) **Risk Factors:**
   a) Deep, dirty, or puncture wounds
   b) Burns, crush injuries, surgical wounds
   c) Umbilical stump infection (neonates)
   d) Injection drug use
   e) Lack of vaccination (most important)
7) **Prevention:**
   a) **Tetanus toxoid vaccination** (TT / Td)
   b) Proper wound cleaning and aseptic technique
   c) Vaccination of pregnant mothers to prevent neonatal tetanus
8) **Treatment:**

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a) **Tetanus immunoglobulin (TIG)**
b) Wound debridement
c) Antibiotics (e.g., metronidazole)
d) Muscle relaxants and supportive ICU care
e) Mechanical ventilation if needed

*[Ref: LANGE, 16th ed., p. 136-138]*

Q. Mention the types of tetanus.
**Types of tetanus:**

1) **Generalized tetanus:** The most common and severe type. It presents with lockjaw (trismus), generalized muscle rigidity, and painful spasms.
2) **Localized tetanus:** Muscle spasms are limited to the area near the wound. It may progress to generalized tetanus if not treated.
3) **Cephalic tetanus:** Occurs after head or facial injuries. Cranial nerves, especially the facial nerve, are involved, causing facial weakness or paralysis.
4) **Neonatal tetanus:** Occurs in newborns due to infection of the umbilical stump. Symptoms usually appear within 3–10 days after birth.

*[Ref: LANGE, 16th ed., p. 136-138]*

Q. How is tetanus transmissible?
**Mode of Transmission of Tetanus:**

1) **Direct Implantation of Spores:** Tetanus occurs when *C. tetani* spores are directly implanted into wounds (cuts, punctures, burns, crush injuries).
2) **Environmental Exposure:** Spores from contaminated soil, dust, rusted objects, and animal or human feces **enter** broken skin or mucous membranes.
3) **Non-Communicable:** No person-to-person transmission; tetanus is not contagious.
4) **Special Case (Neonatal Tetanus):** Infection of the umbilical stump due to unclean delivery practices or contaminated instruments.

*[Ref: Paniker's 11th edition, p 250]*

Q. What are the clinical features of tetanus?
**Clinical Features of Tetanus (C/F):**

1) **Trismus (Lockjaw):** Rigid contraction of the masseter muscles, making it difficult to open the mouth.
2) **Risus Sardonicus:** "Frozen smile" caused by spasm of facial muscles.
3) **Opisthotonus**: Severe arching of the back due to intense spasm of extensor muscles.
4) **Generalized Muscle Rigidity**: Stiffness starting in the jaw and neck, spreading to trunk and limbs.
5) **Painful Muscle Spasms**: Involuntary spasms that can be triggered by minimal stimuli (light, sound, touch).
6) **Difficulty Swallowing and Breathing**: Due to pharyngeal and respiratory muscle spasm.
7) **Autonomic Dysfunction** (in severe cases): Tachycardia, sweating, hypertension, fever, arrhythmias.
8) **Neonatal Features (if relevant)** : Poor suckling, inability to close the mouth, generalized rigidity.

*[Ref: LANGE, 17th ed., p.133]*

Q. Explain how *Clostridium tetani* produces tetanus.
**Answer:**

1) Spores of *Clostridium tetani* are present in soil, dust, and animal feces.
2) Spores enter the body through contaminated or deep wounds.
3) In anaerobic conditions, spores germinate into active bacteria.
4) The bacteria produce a neurotoxin called tetanospasmin.
5) The toxin travels via motor nerves to the spinal cord and brainstem.
6) It blocks inhibitory neurotransmitters (GABA and glycine).
7) This causes sustained muscle contraction, stiffness, spasms, and lockjaw.

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# Section: C
# Chapter-7

| | |
|---|---|
| ❖ Virology<br>❖ Viruses:<br>▪ General consideration, definition.<br>▪ Transmission, properties, classification, portal entry<br>▪ Relation with physical & chemical agent, culture virus, viral<br>▪ Oncogenic vitro, viral antigen and immunity. | ❖ Hemagglutinins<br>❖ Growth and Multiplication of virus<br>❖ Interference:<br>▪ Properties, name, mechanism, use, importance, antiviral drugs<br>❖ Influenza & Para-influenza virus<br>❖ HIV/AIDs |

## Virology

Q. What is the study of Virology?

**Study of virology**: Virology is the branch of microbiology that deals with the study of viruses and virus-like agents. It focuses on the structure, classification, genetics, replication, pathogenesis, and ways to control viruses that infect humans, animals, plants, and even bacteria (bacteriophages).

Virology also explores the interaction between viruses and host organisms, mechanisms of viral infections, immune responses to viral infections, and the development of antiviral drugs and vaccines.

Q. Define virology

**Definition:** "Virology is the branch of science that studies viruses and virus-like agents, including their structure, classification, replication, the diseases they cause, and methods for their prevention and control."

*[Ref.: Prescott* et al., 6th ed., p. 388; *Jawetz, Melnick, & Adelberg's*, 28th ed., p. 403]

Q. What are the main types of virology diagnostic methods?

**Answer:**

1) Direct examination (e.g., microscopy, antigen detection).
2) Virus isolation (cell culture, egg inoculation, animal inoculation).
3) Serological methods (antibody and antigen detection).
4) Molecular methods (PCR, RT-PCR, sequencing).

Q. What are the major antibody detection methods in virology?

**Answer:**

1) ELISA (detects IgM and IgG)
2) Complement Fixation Test (CFT)
3) Neutralization test
4) Hemagglutination Inhibition Test (HAI)
5) Western Blot
6) Indirect Immunofluorescence Assay (IFA)

Q. What are some methods for direct antigen detection?

**Answer:**

1) Direct ELISA
2) Rapid antigen detection kits (e.g., lateral flow tests)

Q. What are the key molecular methods used in virology?

**Answer:**

1) Polymerase Chain Reaction (PCR) for DNA viruses
2) Reverse Transcriptase PCR (RT-PCR) for RNA viruses
3) Real-Time PCR (qPCR) for quantifying viral load
4) Loop-mediated Isothermal Amplification (LAMP) – useful in field settings

*[Ref.: Jawetz*, 27th ed., pp. 409–413; *Murray, 9th ed., pp. 477–481*; *White & Fenner, 4th ed., pp. 36–43]*

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Q. What techniques are used in direct microscopic examination in virology?
**Answer:**

1) **Light microscopy** – to detect viral inclusion bodies in tissues.
2) **Electron microscopy (EM)** – to directly visualize virus particles.

Q. What are the antigen detection methods in virology?
**Answer:**

1) **Immunofluorescence assay (IFA)** – direct and indirect
2) **ELISA** (enzyme-linked immunosorbent assay)
3) **Latex agglutination test**
4) **Immunochromatographic assays** (rapid tests)

# Viruses

**Introduction of Virus:**

Viruses are submicroscopic infectious agents that can replicate only inside living cells. They are acellular and lack cytoplasm, ribosomes, and cell membranes, placing them on the borderline between living and non-living.

Structurally, a virus contains nucleic acid (DNA or RNA) enclosed within a protein coat (capsid). Some viruses also have an additional lipid envelope derived from the host cell. The viral genome carries genetic information for replication, while the capsid protects it and helps in host cell attachment.

Viruses are obligate intracellular parasites—they invade host cells and use the host's metabolic machinery to produce new viral particles. Newly formed viruses are released either by cell lysis or budding.

Viruses infect all types of life: animals, plants, bacteria (bacteriophages), fungi, and algae. They cause many important diseases such as influenza, measles, COVID-19, HIV/AIDS, hepatitis, and rabies. Despite their pathogenic role, viruses are also useful in genetic research, gene therapy, and vaccine development.

*[Ref: LANGE, 17th edition, p. 217]*

Q. Define virus.
**Definition**: "A virus is a submicroscopic, acellular infectious agent that contains either DNA or RNA as its genetic material, enclosed within a protein coat (capsid). Viruses can replicate only inside living host cells and cannot be seen under a light microscope."

*[Ref: LANGE, 17th edition, p. 217]*

Q. Narrate the chemical composition of a virus
**Viruses are composed of four main components:**

1) **Nucleic Acid:**
   - Genetic material: either DNA or RNA (never both).
   - May be single-stranded or double-stranded.
   - Carries genetic information for replication.
   - Non-antigenic.
2) **Proteins:**
   - Form the capsid, which protects the nucleic acid.
   - Provide antigenicity and help in host cell attachment.
   - Capsid subunits (capsomeres) may include enzymes such as:
     - ✓ Neuraminidase – helps in viral entry and release.
     - ✓ Transcriptase/Reverse Transcriptase – helps in genome replication.
3) **Lipids:**
   - Present in the viral envelope (in enveloped viruses).
   - Envelope is derived from the host cell membrane.
   - Destroyed by lipid solvents (e.g., ether, chloroform).
4) **Carbohydrates:**
   - Present as ribose (in RNA) or deoxyribose (in DNA).
   - May also be found as glycoproteins on the viral envelope

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*[Ref: Choudhury. 5th Edition, pp. 460–461]*

Q. What was the first virus?

**Answer** "The first virus discovered was the Tobacco Mosaic Virus (TMV). It was first identified in 1892 by Dmitri Ivanovsky, and later confirmed by Martinus Beijerinck, who also introduced the term 'virus'."

*[Ref.: Jawetz, 27th ed., pp. 22–23]*

Q. Classify viruses with examples.

**Answer:** Viruses can be classified based on various criteria, including the type of nucleic acid, strandedness, presence of an envelope, the nature of the nucleic acid, capsid symmetry, and ether sensitivity.

**Table 7.1 : Classification of Viruses**

| Criteria | Type | Examples |
|---|---|---|
| 1. Based on Type of Nucleic Acid | a) DNA Viruses | • *Poxvirus* – Causes smallpox<br>• *Herpesvirus* – Causes herpes simplex, herpes zoster<br>• *Hepadnavirus* – Causes hepatitis B<br>• *Adenovirus* – Causes diarrhea, sore throat<br>• *Papovavirus* – Causes papilloma<br>• *Parvovirus* – Causes erythema infection |
| | b) RNA Viruses | • *Myxovirus* – Causes influenza, respiratory tract infections<br>• *Rhabdovirus* – Causes rabies<br>• *Coronavirus* – Causes COVID-19<br>• *Picornavirus* – Causes poliomyelitis, otitis media<br>• *Togavirus* – Causes rubella<br>• *Arenavirus* – Causes Lassa fever (not measles)<br>• *Retrovirus* – Associated with diarrhea and HIV<br>• *Hepatitis C virus* – Causes hepatitis C |
| 2. Based on Strandedness | a) Double-stranded Viruses | • *Hepatitis B virus, Herpes simplex virus*<br>• *Smallpox virus, Rotavirus, Adenovirus* |
| | b) Single-stranded Viruses | • *Hepatitis A virus & Hepatitis C virus*<br>• *Poliovirus & Dengue virus, Measles virus*<br>• *Influenza virus* |
| 3. Based on Presence of Envelope | a) Enveloped Viruses | • *Hepatitis B, C, D viruses*<br>• *Herpes simplex virus, Smallpox virus* |
| | b) Non-enveloped Viruses | • *Hepatitis A, E viruses*<br>• *Rotavirus, Poliovirus* |
| 4. Based on Nucleic Acid Polarity | a) Positive-sense RNA Viruses | • *Hepatitis A virus, Poliovirus, Dengue virus* |
| | b) Negative-sense RNA Viruses | • *Influenza virus, Measles virus, Rabies virus* |
| 5. Based on Capsid Symmetry | a) Icosahedral Capsid | • *Hepatitis B virus*<br>• *Herpes simplex virus* |
| | b) Helical Capsid | • *Influenza virus, Measles virus, Rabies virus* |
| 6. Based on Ether Sensitivity | a) Ether-sensitive | • *Herpes simplex virus, Myxovirus, Coronavirus* |
| | b) Ether-resistant Viruses | • *Poxvirus, Parvovirus, Adenovirus,* |

*[Ref. : Choudhury.,* Microbiology, *5th Edition, pp. 467–468]*

Q. Who discovered the virus first?

**Answer:** "Dmitri Ivanovsky first discovered the virus in 1892, and later in 1898 Martinus Beijerinck confirmed the discovery and coined the term 'virus'."

*[Ref.: Prescott's Microbiology, 10th ed., pp. 362–363]*

Q. Name five DNA and five RNA viruses

Table: 7.2 DNA and Five RNA Viruse

| *DNA Viruses:* | | *RNA Viruses:* | |
|---|---|---|---|
| 1. Poxvirus | 4. Adenovirus | 1. Myxovirus | 4. Togavirus |
| 2. Herpesvirus | 5. Papillomavirus | 2. Rhabdovirus | 5. Coronavirus |
| 3. Hepadnavirus | | 3. Picornavirus | |

Q. What are the special properties of viruses?

**Special properties of viruses:**

1) Viruses are the smallest infectious agents and are submicroscopic.
2) Obligate intracellular parasites — they can replicate only inside living cells.
3) Acellular in nature — lack true cell structure.
4) Contain only one type of nucleic acid (DNA *or* RNA, never both).
5) Lack cell wall, cytoplasm, ribosomes, mitochondria, and most metabolic machinery.
6) Cannot synthesize proteins independently due to absence of ribosomes.
7) Contain few or no enzymes for energy metabolism.
8) Multiply by replication (assembly inside host cells), not by binary fission.
9) Resistant to antibiotics but sensitive to interferons and antiviral drugs.
10) Capable of transmission, infection, and causing epidemics/pandemics.

*[Ref: Choudhury. 5th edition, p. 455; Paniker's, 11th edition, p. 377]*

Q. What are the physical properties of viruses?

**Physical Properties of Viruses**:

1) **Temperature Sensitivity:**
   - Generally inactivated at 50–60°C for 30 minutes.
   - Some viruses (e.g., Polio, Hepatitis, Adeno-associated viruses) are more heat-resistant.
   - Cold-resistant; can be preserved at –35°C to –70°C.
   - Freeze-drying is effective for long-term storage.
2) **pH Sensitivity:**
   - Stable at pH 5–9.
   - Inactivated by extreme acidity or alkalinity.
3) **Radiation Sensitivity:** Inactivated by UV light, X-rays, and high-energy particles.
4) **Vital Dyes & Photodynamic Inactivation:**
   - Dyes (e.g., neutral red, acridine orange) are absorbed by viral nucleic acids.
   - Dye-treated viruses become more sensitive to UV light.

Q. What are the chemical properties of viruses?

**Chemical properties of viruses:**

1) **Glycerol Sensitivity**
   - 50% glycerol preserves many viruses.
   - Kills non-spore-forming bacteria at this concentration.
2) **Ether Sensitivity**
   - Enveloped viruses are sensitive to ether.
   - Non-enveloped viruses are resistant to ether.
3) **Disinfectant Response**
   - **Effective disinfectants:** Hydrogen peroxide, potassium permanganate, sodium hypochlorite, iodine, formaldehyde, glutaraldehyde.
   - **Ineffective disinfectants:** Phenols (generally ineffective against viruses).
4) **Antiviral Chemotherapy**
   - Some antiviral drugs exist.
   - Use is limited due to toxicity to host cells.

*[Ref.: Choudhury.* Microbiology, *5th Edition, p. 461]*

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Q. Why are viruses obligate intracellular parasites?

**Answer**: "Viruses are obligate intracellular parasites because they lack mitochondria and ribosomes, and therefore cannot produce their own energy or proteins. They depend entirely on the host cell's machinery to replicate and survive, so they can only live and multiply inside living cells."

*[Ref: LANGE, 17th edition, p. 217]*

Q. What are the basic structural components of a virus?

**Basic Structural Components of a Virus:**

1) **Nucleic acid core** – DNA or RNA, carrying genetic information.
2) **Capsid** – protein shell that protects the nucleic acid.
3) **Envelope** – lipid layer derived from the host cell (present in some viruses).

*[Ref.-LANGE, 17th Edition, p. 220; Paniker's Microbiology, 11th Edition, p. 377–378]*

Q. Give the structure of a complete virus particle

Q. Draw and level of an enveloped virus.

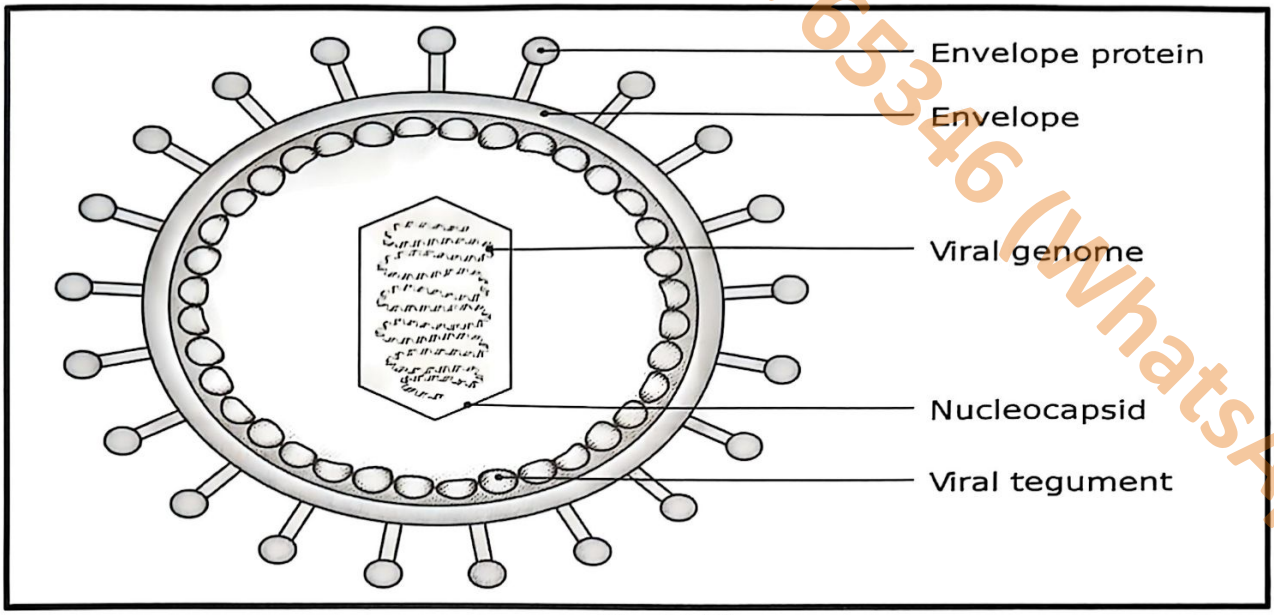


Fig.-7.1 Virus

Q. Name some important pathogenic virus with their portal entry.

Table-7.3 **Important Pathogenic Viruses and Their Portal of Entry**

| Pathogen | Disease | Portal of Entry |
|---|---|---|
| Influenza virus | Influenza | Respiratory tract |
| Rhinovirus | Common cold | Respiratory tract |
| Epstein-Barr virus | Infectious mononucleosis | Oral/oropharyngeal route |
| Norovirus | Gastroenteritis | Gastrointestinal tract |
| Rotavirus | Gastroenteritis | Gastrointestinal tract |
| Hepatitis A virus | Hepatitis A | Gastrointestinal tract |
| Poliovirus | Poliomyelitis | Gastrointestinal tract |
| Rabies virus | Rabies | Skin (bite from infected animal) |
| Human papillomavirus (HPV) | Genital warts | Genital tract |
| Herpes simplex virus 2 | Genital herpes | Genital tract |

Q. How are viral diseases transmitted?

**Modes of Transmission of Viral Diseases:**

1) **Ingestion** – Entry through contaminated food or water.
   *Examples:* Poliovirus, Hepatitis A virus.

2) **Inhalation** – Spread via respiratory droplets or aerosols.
*Examples:* Influenza virus, Measles virus.
3) **Inoculation** – Direct entry through bites or stings by arthropods.
*Examples:* Dengue virus, Zika virus, West Nile virus.
4) **Direct Contact** – Transmission via close contact with infected individuals or their secretions.
***Examples:*** Herpes simplex virus, Human papillomavirus (HPV).

*[Ref.: LANGE Review, 17th ed., p. 33]*

Q: Classify capsid symmetry with example.
Classification of Capsid Symmetry

1) **Icosahedral (Cubical) Symmetry**: Capsid has 20 triangular faces forming a roughly spherical shape.
   - ***Examples:*** Human papillomavirus, Rhinovirus, Hepatitis B virus, Herpesviruses
2) **Helical Symmetry**: Capsid proteins arranged in a helix around the nucleic acid.
   - ***Examples:*** Tobacco mosaic virus, Arenaviruses, Bunyaviruses
3) **Complex Symmetry**: Capsid structure does not fit purely helical or icosahedral patterns.
   - ***Example:*** Poxvirus

*[Ref: Paniker's Microbiology, 11th Edition, p. 377–378]*

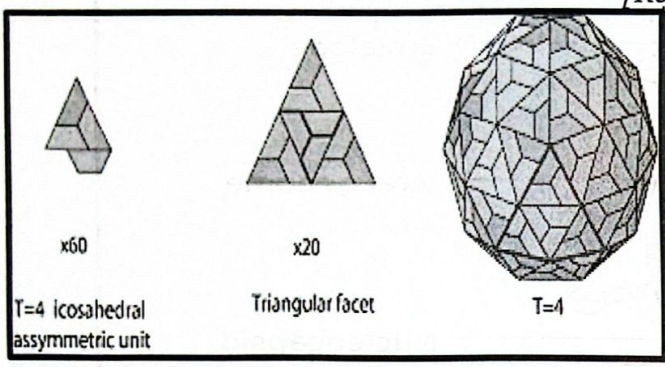


Fig.-7.2 Icosahedral Symmetry (Cubical)

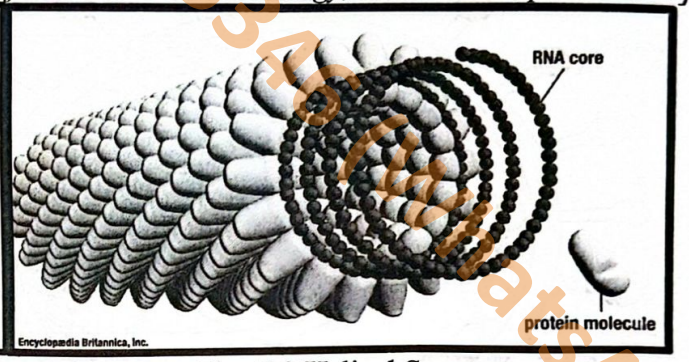


Fig.-7.3 Helical Symmetry

Q. What are the functions of the viral capsid?
**Functions of the Viral Capsid:**

1) **Protection** – Shields the viral nucleic acid from degradation.
2) **Attachment** – Facilitates binding to host cell receptors for entry.

*[Ref.: Paniker's Microbiology, 11th Edition, pp. 377–378]*

Q. What is an envelope? Give its functions.
**Envelope:** The envelope is a lipoprotein membrane surrounding the capsid of some viruses. The lipid part is derived from the host cell membrane, while the protein part is virus-encoded.
**Functions of the Envelope:**

1) **Protection** – Shields the viral genome.
2) **Attachment and Entry** – Helps the virus bind to and enter host cells.

**Note:** Enveloped viruses are **more sensitive** to heat, drying, detergents, and lipid solvents (e.g., alcohol, ether) than non-enveloped viruses.

*[Ref: Paniker's, 11th edition, p. 378; LANGE, 17th edition, p. 220]*

Q. Name the smallest and the largest viruses.
**Smallest Viruses:**

- **RNA virus:** Picornavirus
- **DNA virus:** Parvovirus B19

**Largest Virus: DNA virus:** Smallpox virus
**Note:** Smallpox virus is the only virus visible under a light microscope.

*[Ref: Sharif, 8th edition, p. 304]*

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Q. "Recently, outbreaks due to viral agents have caused public panic in different parts of Bangladesh." Which viruses were involved and why was panic created?

**Answer:**

Viruses Involved in Recent Outbreaks in Bangladesh:

1) Coronavirus (COVID-19)
2) Dengue virus
3) Nipah virus

**Reasons for Public Panic**:

1) **COVID-19:** High transmissibility, severe disease in elderly and patients with comorbidities, and global lockdowns.
2) **Dengue virus:** Can cause dengue hemorrhagic fever and shock, which are potentially fatal.
3) **Nipah virus:** Causes fatal encephalitis and has no specific treatment.

*[Ref: Sharif, 8th edition, p. 305]*

# Viral oncogenesis in vitro:

Q. Define **oncogenesis.**

**Definition:** Oncogenesis is the process by which normal cells are transformed into cancerous cells, leading to tumor formation. This can occur due to genetic mutations, environmental factors, or infection by oncogenic viruses, which can induce cellular transformation and tumor development in humans and animals.

*[Ref-CHOUDHURY M.R./5th edition/463]*

Q. Explain the portal of entry of important viral pathogen

**Portal of Entry of Important Viral Pathogens**: Viruses enter the human body through various routes depending on their structure and tropism. The following classification highlights the common portals of entry along with examples of viruses and associated diseases.

Table: 7.4 Portal of entry of important viral pathogen

| Portal of Entry | Examples of Viruses | Associated Diseases |
|---|---|---|
| Respiratory Tract | Influenza virus, Rhinovirus, Coronavirus (COVID-19), Respiratory syncytial virus, Measles virus, Mumps virus, Rubella virus, Adenovirus, Varicella-zoster virus, Parvovirus B19, Epstein-Barr virus | Influenza, Common cold, Pneumonia, Bronchitis, Measles, Mumps, Rubella, Chickenpox, Slapped Cheek Syndrome, Infectious mononucleosis |
| Gastrointestinal Tract | Hepatitis A & E viruses, Poliovirus, Rotavirus, Norovirus, Adenovirus, Astrovirus, Calicivirus, Reoviruses, Enteroviruses | Hepatitis A/E, Poliomyelitis, Viral diarrhea |
| Genital Tract | Herpes simplex virus type 2, HIV, HPV, Hepatitis B & C, Zika virus | Genital herpes, AIDS, Genital warts, Hepatitis B/C, Zika fever |
| Blood & Parenteral Route | HIV, HBV, HCV, HDV, CMV | AIDS, Hepatitis B/C/D, CMV infections |
| Transplacental | Rubella virus, CMV, Zika virus, Parvovirus B19, HIV | Congenital infections (rubella syndrome, microcephaly, hydrops fetalis, etc.) |
| Skin & Vector-borne | Rabies virus, Dengue virus, Yellow fever virus, Zika virus, HPV | Rabies, Dengue, Yellow fever, Zika fever, Warts |

# Culture of virus:

Q. What is viral culture?

**Viral culture:** Viral culture is a laboratory method used to detect and study viruses. Specimens suspected of containing viruses are introduced into living cell lines. If the virus is present, it infects the cells and

produces cytopathic effects (CPE)—visible changes in the cells. A positive culture confirms the presence of the virus.

Q. Describe the methods of culturing virus.

**Methods of Culturing Viruses:**

1) **Embryonated Egg Culture:**
   - Virus injected into CAM, allantoic, amniotic cavities, or yolk sac.
   - Observations: embryo death, pock formation, hemagglutinin production.
2) **Tissue (Cell) Culture:**
   - Virus grows in living cell layers.
   - Observations: cytopathic effects, reduced cell metabolism, viral antigens, hemadsorption, viral interference, oncogenic transformation.

*[Ref.: CHOUDHURY M.R., 5th edition, pp. 462–463]*

# Viral antigens and immunity

Q What is viral antigen?

**Viral antigens**: **Viral antigens** are the substances (usually proteins or glycoproteins) present on the surface or inside a virus that are recognized by the body's immune system and stimulate an immune response.

**Types of viral antigens:**

1) **Surface antigens (Envelope proteins / Spike proteins):** Found on the outer surface of the virus.
   **Example:** Hemagglutinin (HA) and Neuraminidase (NA) in influenza virus.
2) **Capsid antigens:** Present in the protein coat (capsid) of the virus.
   **Example:** Capsid protein of Adenovirus.
3) **Internal antigens:** Found inside the virus (not exposed outside).
   **Example:** Core antigen of Hepatitis B virus (HBcAg).

Q What is viral immunity

**Viral immunity**: Viral immunity is the immune response of the body that protects against viral infections through innate and adaptive mechanisms, including antibodies and T-cells.

It includes two main types:

1) **Innate immunity (natural immunity):**
   - First line of defense
   - Includes skin, mucous membranes, interferons, and natural killer (NK) cells
   - Acts quickly but is non-specific
2) **Adaptive immunity (specific immunity):**
   - Develops after infection or vaccination
   - **Humoral immunity:** Antibodies (IgM, IgG) neutralize the virus
   - **Cell-mediated immunity:** Cytotoxic T-cells destroy virus-infected cells

Q. Where are most antigenic determinants located in viruses?

**Answer:** Most antigenic determinants of viruses are present on the **surface proteins**, especially envelope glycoproteins or capsid proteins.

Q. Name three common serological tests used to detect antiviral antibodies.

**Answer:**

1) Neutralization Test
2) Hemagglutination Inhibition Test
3) Complement Fixation Test

*[Ref: Choudhury M.R., 5th edition, p. 463]*

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# Section-G
# Chapter-19

| | |
|---|---|
| ▪ Introduction of Immunology<br>▪ Immunology & Immunity<br>▪ Innate immunity- Non-specific antimicrobial chemical.<br>▪ Cells & Organ of Immune System<br>▪ NK cells | ▪ T-lymphocyte<br>▪ B-Lymphocytes<br>▪ Macrophages & Dendric cells<br>▪ Antigen and Immunogen Superantigen<br>▪ Thymus Dependent antigen<br>▪ Thymus independent antigen |

## Immunology

Q. What is immunology?

**Answer:** The word *"Immunis"* is derived from Latin, meaning *"free from burden or taxes."* In medical science, individuals who are resistant to or protected from specific diseases are said to be immune.

**Immunology** is the branch of biomedical science that deals with the study of the immune system, its **structure**, functions, and the mechanisms of defense against infectious agents and foreign substances.

*[Ref:. Akram, Immunology*, 7th ed., p.1]

Q. Define immunology.

**Immunology**: "Immunology is the branch of medical science that studies the development and function of both cellular and humoral components of the immune system, through which the body identifies, destroys, or neutralizes foreign substances, including disease-causing microorganisms".

*[Ref:. Akram, Immunology*, 7th ed., p.1]

Q. Name the branches of immunology.

**Branches of immunology**: There are several branches of immunology, among which the major subdivisions are:

1) **Classical Immunology:** Studies the interaction between body systems, pathogens, and immunity.
2) **Immunochemistry:** Focuses on the chemical structure and interactions of antigens and antibodies.
3) **Immunobiology:** Concerned with the biological functions of immune cells and tissues.
4) **Immunogenetics:** Studies the genetic basis of immune responses, including immunoglobulin gene regulation.
5) **Clinical Immunology:** Involves diagnosis, pathogenesis, and treatment of immune-related diseases.
6) **Immunotherapy:** Applies immune-based treatments such as vaccines, immunoglobulins, and desensitization.
7) **Immunohematology:** Studies immune mechanisms involved in blood disorders.
8) **Immunopharmacology:** Examines pharmacological effects of immune-related molecules and mediators.
9) **Diagnostic Immunology:** Focuses on detecting diseases using antigen-antibody reactions in diagnostic tests.
10) **Serology:** Involves the study of antibody-mediated immune responses in serum.
11) **Reproductive Immunology:** Studies immune responses in reproduction, including fetal tolerance during pregnancy.

*[Ref: Akram, **Immunology**, 7th ed., pp. 6–7]*

Q. What are its applications in immunology?

**Applications of Immunology:**

1) **Vaccine development** – Prevention of infectious diseases (e.g., measles, hepatitis B, COVID-19).
2) **Diagnosis of infections** – Using immunological tests like ELISA and rapid antigen detection.
3) **Allergy and hypersensitivity management** – Understanding and treating allergic reactions.
4) **Autoimmune disease research and treatment** – Managing diseases like SLE, rheumatoid arthritis.
5) **Cancer immunotherapy** – Using the immune system to target and kill cancer cells.

6) **Organ transplantation** – Preventing graft rejection through immunosuppressive therapy.
7) **Treatment of immunodeficiency** – Managing conditions like AIDS or congenital immune disorders.
8) **Development of monoclonal antibodies** – For targeted therapy and diagnosis.

*[Ref: Akram,* Immunology*, 7th ed., p.1]*

Q. Write down the applications of immunology in medical science.
Q. Explain the importance/applications of immunology in the health sector.

**Applications of Immunology in Health:**

1) **Disease diagnosis:** Detection of antibodies/antigens → e.g., ASO titer, VDRL, Widal, HBsAg, Rheumatoid factor, CEA.
2) **Understanding diseases:** Explains autoimmune disorders, allergies, transplant rejection, tumor immunity.
3) **Prevention & treatment:**
   - Active immunization → vaccines (measles, polio, COVID-19).
   - Passive immunization → immunoglobulins.
   - Immunotherapy → cancer, chronic infections.
4) **Blood transfusion:** Blood grouping, Rh typing, cross-matching.
5) **Transplantation:** Tissue typing, histocompatibility testing → reduce graft rejection.
6) **Forensic uses:** Paternity test, identification of body fluids, verification of food/meat species.

*[Ref: Akram, Immunology, 7th ed., p.6]*

Q. How does immunity help in the diagnosis of diseases? Give examples.
**Answer:** Immunity aids in disease diagnosis by detecting specific antibodies or antigens in the body. This helps identify infections, autoimmune disorders, and cancers.

**Examples of immunological tests:**

- **ASO titer** – for streptococcal infections
- **VDRL** – for syphilis
- **WIDAL** – for typhoid fever
- **HBsAg** – for hepatitis B
- **RA test** – for rheumatoid arthritis
- **CEA** – for cancer diagnosis and monitoring

*[Ref:. Akram, Immunology, 7th ed., p.6]*

Q. How does immunity help in forensic medicine?
Immunology is used in forensic medicine for:

- **Paternity testing** – to determine biological relationships
- **Stain identification** – such as blood or semen in crime scene analysis
- **Meat testing** – to detect the source or type of meat in food or forensic cases

These applications rely on antigen-antibody reactions to ensure accurate identification.

*[Ref: Akram, Immunology, 7th ed., p.6]*

# Immunity

Q. What is immunity?
**Immunity**:The term immunity refers to "all the mechanisms used by the body to resist against environmental agents that are foreign to it". Immunity meant protection from disease and more specifically protection from infectious disease.

In other words, it is the relative resistance of the host to reinfection by a given or specific microbe. These agents may be microorganisms or their products, foods, chemicals, drugs, pollen, animal hair, dander etc.

*[Ref.. Akram/Immunology/7th edition/1-2]*

Q. Define immunity.
Definition of Immunity: Immunity is the body's defense mechanism that enables it to recognize foreign substances and respond by neutralizing, eliminating, or metabolizing them, thereby providing protection

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against infections and even cancer.
In other words, immunity refers to the host's response to injury caused by microorganisms or any other foreign substances.

*[Ref: Paniker's Microbiology, 11th ed., p.73]*

Q. What are the types of immunity?
**Types of Immunity:**
**A. Innate Immunity (Inborn or Genetic):**
- Present from birth.
- Non-specific and immediate defense against pathogens.

**B. Acquired Immunity (Developed after birth):**
1) **Active Immunity** *(Body produces its own antibodies)*
   a) **Natural:** Acquired through natural infection.
   b) **Artificial:** Acquired through vaccination (immunization).
2) **Passive Immunity** *(Ready-made antibodies are received)*
   a) **Natural:** Maternal antibodies transferred to the baby through placenta or breast milk.
   b) **Artificial:** Injection of antibodies from another source (e.g., antiserum, immunoglobulin).

*[Ref: Akram, **Immunology**, 7th ed., p.9]*

Q. Classify immunity.
**Immunity** can be classified into two major types:
**A. Innate Immunity (Non-specific, Inborn Immunity):**
- Present at birth; not acquired through contact with antigens.
- Provides immediate but non-specific protection.

1) **Genetic/Constitutional Factors:** Depends on factors like birth, race, age, and sex.
2) **Mechanical and Physiological Barriers:**
   - Keratinized skin
   - Intact mucous membranes
   - Mucociliary clearance
   - Reflexes (e.g., coughing, sneezing)
3) **Humoral Factors:**
   - Normal bacterial flora
   - Gastric acid
   - Complement system
   - Interferons
4) **Cellular Components:**
   - Macrophages
   - Neutrophils & Eosinophils
   - Natural Killer (NK) cells
   - Fever or high body temperature (miscellaneous defense)

**B. Acquired Immunity (Specific Immunity):**
- Develops after exposure to a specific antigen.
- Not present at birth; more targeted and has memory.

1) **Active Immunity (Body produces its own antibodies):**
   a) **Natural:** After infection (clinical or subclinical), e.g., Hepatitis A infection
   b) **Artificial:** Through vaccines
      - **Types**: Bacterial vaccines, viral vaccines, toxoids, live attenuated vaccines
2) **Passive Immunity (Ready-made antibodies are received):**
   a) **Natural:**
      - Antibodies from mother to fetus via placenta
      - Antibodies from mother to infant via breast milk
   b) **Artificial:**
      - Injection of antisera or antitoxins

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- Examples:
  - ✓ **TIG** (Tetanus Immunoglobulin)
  - ✓ **ATS** (Anti-tetanus serum)
  - ✓ **ADS** (Anti-diphtheria serum)

*[Ref: Choudhury, 5th ed., pp. 97–98; Akram,* Immunology*, 7th ed., p.9]*

Q. Write down the beneficial and harmful effects of immunity.

**Beneficial Effects of Immunity:**

1) **Prevention of diseases:** Vaccination helps the body develop immunity against diseases like measles and polio.
2) **Protection after infection:** Antibodies formed after infection protect against future attacks.
3) **Protection against cancer:** The immune system destroys abnormal cells.
4) **Faster response on reinfection:** Memory cells help the body respond quickly to the same pathogen.
5) **Protection for newborns:** Antibodies are passed from mother to baby through placenta and breast milk.

**Harmful Effects of Immunity:**

1) **Allergic reactions:** Overreaction of the immune system causes allergies like asthma and eczema.
2) **Autoimmune diseases:** The immune system attacks its own tissues (e.g., rheumatoid arthritis).
3) **Transplant rejection:** Immune system may reject transplanted organs.
4) **Tissue damage:** Prolonged immune response can damage body tissues.
5) **Immune deficiency:** Weak immunity increases the risk of infections (e.g., AIDS).

*[Ref: LANGE, 17th ed., p.496; Akram, 7th ed.; Paniker's, 11th ed.]*

Q. What are the components of natural immunity?

**Answer:** Components of the immune system involved in natural immunity include:

1) ***Cellular Components:***
   - **Macrophages:** Professional phagocytic cells and antigen-presenting cells (APCs)
   - B-lymphocytes (B-cells) and T-lymphocytes (T-cells)
   - Natural Killer (NK) cells
   - Neutrophils and Eosinophils
   - Mast cells and Basophils
   - Platelets
2) ***Soluble Components:***
   - Immunoglobulins (antibodies)
   - Complement system
   - Cytokines
   - Inflammatory mediators
3) ***Mechanical Barriers:***
   - Intact skin and mucous membranes
   - Mucociliary apparatus of the upper respiratory tract
   - Normal microbial flora at various body sites
4) ***Genetic Factors:*** *For example, individuals deficient in glucose-6-phosphate dehydrogenase (G6PD) show resistance to* Plasmodium falciparum *infection.*

Q. Which cells are involved in cell-mediated immunity?

**Cell-mediated immunity** is an immune response that does **not** involve antibodies or complement. Instead, it involves activation of:

1) Macrophages
2) Natural Killer (NK) cells
3) Antigen-specific cytotoxic T-lymphocytes (CD8+ T cells)
4) Release of various cytokines to coordinate the immune response

*[Ref: Akram,* ***Immunology****,* 7th ed., p. 84]

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# Innate or nonspecific immunity:

Q. What is innate immunity?

**Innate immunity**: Innate immunity is the natural resistance an individual possesses by birth. It involves molecular and cellular mechanisms that are already present before infection and act immediately to prevent or eliminate pathogens. It is also known as the first and second line of defense, as it works rapidly within hours of encountering microbes.

*[Ref: Akram,* Immunology, *7th ed., pp. 8–9]*

Q. Classify innate immunity with example.

**Innate immunity is classified into**:

1) **Individual immunity** – Resistance varies among individuals of the same species.
   ***Example:*** Severity of infection differs between two persons.
2) **Racial immunity** – Resistance differs among races of the same species due to genetic and environmental factors.
   ***Example:*** African blacks are more susceptible to tuberculosis than American whites.
3) **Species immunity** – Resistance differs between species.
   ***Example:*** *V. cholerae, S. typhi, N. gonorrhoeae,* and *T. pallidum* infect humans but not animals.

*[Ref: Akram, Immunology, 7th ed., p. 9]*

Q. What are the factors of innate immunity?

Innate immunity provides immediate, non-specific defense and includes:

1) **Physical/Mechanical factors**:
   - **Skin**: Physical barrier, secretes sebum with antimicrobial action.
   - **Mucous membranes**: Trap microbes in respiratory, digestive, and urogenital tracts.
   - **Mechanical removal**: Ciliary action, coughing, sneezing, vomiting, diarrhea, flushing by saliva, tears, urine.
2) **Chemical factors**:
   - **Lysozyme** (tears, saliva) – destroys bacterial cell walls.
   - **Defensins** – damage microbial membranes.
   - **Cytokines (interferons)** – resist viral infection.
   - **Acidic pH** – stomach and skin inhibit growth.
3) **Biological/Cellular factors**:
   - **Complement system** – destroys microbes (lectin, alternative pathways).
   - **Phagocytes** – neutrophils, macrophages, dendritic cells.
   - **Mast cells** – inflammation; NK cells – kill virus-infected/abnormal cells.
   - **Normal flora** – compete with pathogens.
4) **Other innate responses**: Phagocytosis, inflammation, fever, nutritional immunity (iron sequestration), and acute-phase proteins (e.g., C-reactive protein).

*[Ref: Akram,* Immunology, *7th ed., p. 9]*

Q. Which factors affect innate immunity?

**Answer:** The effectiveness of innate immunity is influenced by several factors:

1) **Age:**
   - Newborns and elderly people are more prone to infections due to weak immunity.
   - The placenta protects the fetus, but some infections (e.g., rubella, CMV, toxoplasma, herpes) can cross it and cause birth defects.
2) **Hormonal influences:**
   - Diseases like diabetes, hypothyroidism, and adrenal disorders increase infection risk.
   - High blood sugar in diabetes favors infections such as *Staphylococcal* sepsis.
   - Corticosteroids suppress immunity by reducing inflammation, phagocytosis, antibody production, and hypersensitivity.
   - High steroid levels in pregnancy may also increase susceptibility.
3) **Nutrition:** Malnutrition lowers both antibody production and cell-mediated immunity, making the body less able to fight infections.

*[Ref: Paniker's Microbiology, 11th ed., p. 74]*

Q. What are the components of innate immunity?

**Answer:** Innate immunity is the natural defense system present from birth. It acts rapidly and non-specifically against infections. Its components are:

1) **Cellular components:**
   - **Macrophages** – phagocytose and digest microbes.
   - **Neutrophils** – first responders, engulf bacteria.
   - **Dendritic cells** – phagocytose and activate adaptive immunity.
   - **Natural Killer (NK) cells** – kill virus-infected and tumor cells.
   - **Mast cells & basophils** – release histamine, promote inflammation.
2) **Soluble (humoral) components:**
   - **Complement system** – protein cascade that lyses microbes and enhances phagocytosis.
   - **Cytokines (e.g., interferons, interleukins)** – signaling proteins that regulate immune response and resist viral infections.
   - **Acute phase proteins (e.g., C-reactive protein)** – enhance defense.
   - **Inflammatory mediators (e.g., histamine, prostaglandins)** – recruit immune cells.

Q. How do the components of innate immunity work together?

**Answer:** The components of innate immunity act together to provide rapid, non-specific defense against pathogens:

1) **Macrophages:** Engulf and digest microbes by phagocytosis and release signaling molecules.
2) **Neutrophils:** Rapidly migrate to infection sites and destroy bacteria.
3) **Natural Killer (NK) cells:** Kill virus-infected and cancer cells without prior exposure.
4) **Soluble components (complement system):** Bind to pathogens, promote opsonization, and enhance phagocytosis.
5) **Interferons:** Released by virus-infected cells to inhibit viral replication and protect neighboring cells.
6) **Barrier defenses (skin and mucosa):** Prevent entry of pathogens and support cellular defenses.

*[Ref: LANGE Review, 17th ed., p. 494]*

Q. What are the cells involved in innate immunity?

**Answer:** The main cells involved in innate immunity are:

1) **Macrophages** – Phagocytose and destroy pathogens
2) **Neutrophils** – First responders that kill microbes
3) **Eosinophils** – Defend against parasites and help in allergies
4) **Basophils** – Release histamine in inflammatory reactions
5) **Mast cells** – Involved in inflammation and allergic responses
6) **Natural Killer (NK) cells** – Kill virus-infected and cancer cells
7) **Dendritic cells** – Capture antigens and activate immune responses
8) **Platelets** – Assist in inflammation and immune defense

*[Ref: Akram, Immunology, 7th ed., p.13]*

Q. Write the determinants of innate immunity

**Answer:** The determinants of innate immunity are:

1) **Genetic factors:** Genetic makeup influences natural resistance or susceptibility to diseases
   ***Example:*** Some populations show resistance to falciparum malaria; racial differences exist in tuberculosis.
2) **Age:** Newborns and elderly individuals have weaker innate immunity and are more susceptible to infections.
3) **Humoral and metabolic factors:** Conditions like diabetes reduce the body's defense against infections.
4) **Nutritional status:** Malnutrition weakens immunity and increases the risk of infections.

*[Ref: Akram, Immunology, 7th ed., pp. 17-18]*



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Q. Describe the barriers of innate immunity?

**Answer:** The innate immune system protects the body through the following barriers:

1) **Anatomical barriers:**
   - **Skin** – Dry, acidic, cooler than body temperature; produces antimicrobial secretions; constant shedding removes microbes; normal flora prevent colonization; SALT provides local defense.
   - **Mucous membranes** – Secrete mucus that traps microbes; mucus contains lysozyme and secretory IgA; normal flora compete with pathogens; continuous shedding removes microbes; MALT provides local defense.
   - **Bony structures** – Skull, ribs, and vertebrae protect vital organs from injury and infection.
2) **Mechanical removal:**
   - Ciliary action clears respiratory passages.
   - Coughing, sneezing, vomiting, diarrhea expel microbes.
   - Flushing by urine, tears, saliva, sweat removes pathogens.
3) **Chemical factors:**
   - Antimicrobial substances (e.g., lysozyme, defensins, sebum).
   - Acidic pH of skin and stomach inhibits microbes.
   - Pattern-recognition receptors (PRRs) detect microbial components like LPS, peptidoglycan, and viral RNA.

*[Ref: Akram, Immunology, 7th ed., pp. 9-11]*

Q. Write down the characteristics of innate immune response.

**The innate immune response has the following characteristics:**

1) Present from birth
2) Non-specific (broad-spectrum) response against pathogens
3) Acts immediately on exposure to microbes
4) No immunological memory or long-lasting protection
5) Limited recognition molecules (pattern-recognition receptors)
6) Phylogenetically ancient system
7) No improved response on repeated exposure
8) Poor discrimination among different foreign antigens

*[Ref: Akram, Immunology, 7th ed., p. 9]*

Q. Identify the physiochemical barriers (Innate) against infection.

**Answer: Physiochemical barriers** are the first line of defense in innate immunity and include:

1) **Physical (Mechanical) Barriers:**
   - **Skin:** Acts as a tough, dry, acidic barrier that prevents microbial entry.
   - **Mucous membranes:** Produce mucus to trap microbes.
   - **Cilia:** Move mucus and trapped microbes out of respiratory tract.
   - **Flushing actions:** Coughing, sneezing, vomiting, diarrhea, tears, saliva, urine flush out microbes.
2) **Chemical Barriers:**
   - **Sweat and sebum:** Contain organic acids that inhibit bacterial growth.
   - **Low pH of stomach acid:** Kills most ingested microbes.
   - **Lysozyme:** Enzyme in tears, saliva, mucus that breaks bacterial cell walls.
   - **Bile acids:** Antimicrobial action in intestines.
   - **Lactoferrin and transferrin:** Bind iron to prevent bacterial growth.
   - **Interferons and cytokines:** Antiviral proteins that inhibit viral replication.

*[Ref: Akram, Immunology, 7th ed., pp. 9-11]*

Q. How does innate immunity protect us from hostile environments?

Q. Write down the mechanism of action of innate immunity.

**Mechanism of action of innate immunity:**

1) **Genetic Factors:**
   - Some people have genetic traits that make them resistant to certain infections.

- Example: People with glucose-6-phosphate dehydrogenase deficiency or sickle cell anemia are resistant to *Plasmodium falciparum* malaria.

2) **Barriers that Prevent Microbial Entry:**
   - **Keratin layer of intact skin:** Acts as a tough physical barrier.
   - **Lysozyme in tears and secretions:** Breaks down bacterial cell walls.
   - **Respiratory cilia:** Move mucus containing trapped microbes out of airways.
   - **Low pH in stomach and vagina, fatty acids in skin:** Inhibit microbial growth.
   - **Surface phagocytes (e.g., alveolar macrophages):** Ingest and destroy microbes.
   - **Defensins (antimicrobial peptides):** Create holes in microbial membranes.
   - **Normal flora of throat, colon, and vagina:** Compete with pathogens to prevent infection.
3) **Elimination of Invaded Microbes and Limiting Their Growth:**
   - **Natural Killer (NK) cells:** Kill virus-infected and abnormal cells.
   - **Neutrophils:** Engulf and destroy microbes.
   - **Macrophages and dendritic cells:** Phagocytose microbes and present antigens to activate adaptive immunity.
   - **Interferons:** Stop viruses from multiplying.
   - **Complement system:** Marks microbes for destruction (opsonization) and kills some directly.
   - **Transferrin and lactoferrin:** Bind iron, depriving bacteria of nutrients needed for growth.
   - **Inflammatory response:** Contains infection and recruits immune cells to the site.

*[Ref: LANGE Review, 17th ed., p. 494]*

Q. Explain the Antigen-Nonspecific Antimicrobial Chemicals.

**Answer:** Antigen-nonspecific antimicrobial chemicals are innate immune substances produced by the body that protect against infections without prior exposure to antigens. They act broadly against microbes.

**Examples:**

1) **Hydrochloric acid and digestive enzymes:** Present in the stomach; destroy swallowed microorganisms.
2) **Lysozyme:**
   - Found in tears, saliva, mucus, and plasma.
   - Breaks bacterial cell walls (peptidoglycan), causing lysis.
3) **Defensins (α and β) and cryptdins:**
   - Small antimicrobial peptides found in skin, plasma, respiratory tract, and intestines.
   - Form pores in microbial membranes leading to cell death.
4) **Lactic acid and fatty acids:**
   - Present in sweat and skin oils.
   - Create an acidic environment that inhibits microbial growth.
5) **Lactoferrin and transferrin:** Bind iron, making it unavailable for microbial growth.
6) **Fibronectin:** Acts as an opsonin by coating microbes and enhancing phagocytosis.
7) **Complement system:** A group of plasma proteins that directly destroy microbes or assist phagocytes.
8) **Acute-phase proteins (e.g., C-reactive protein):** Increase during infection and enhance immune responses.
9) **Tumor Necrosis Factor-α (TNF-α):** Activates immune cells and helps control infections.
10) **Surfactant proteins A and D:** Found in lungs; act as opsonins to enhance phagocytosis.
11) **APOBEC3G:** Restricts retroviral replication by inducing mutations in viral DNA.

*[Ref: Prof. Akram, Immunology, 7th ed., p. 12]*

# Adaptive (Acquired) Immunity:

Q. What is acquired immunity?

**Answer:** Acquired immunity is a specific immunity that develops after exposure to an antigen. It is present only in vertebrates and develops after birth, improving with exposure to different pathogens.

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It involves B-lymphocytes, which produce antibodies, and T-lymphocytes, which help in cell-mediated defense, providing specific recognition and immunological memory for faster responses on re-exposure.

*[Ref: f. Akram, Immunology, 7th ed., p. 19]*

Q. Define acquired or adaptive or specific immunity.

**Acquired immunity:** Acquired immunity (also called adaptive or specific immunity) is the immune response that develops after exposure to a foreign substance (antigen). It is highly specific, found only in vertebrates, and becomes fully functional after birth as the body encounters various infections or immunogens.

*[Ref:. Akram, Immunology, 7th ed., p. 19]*

Q. Describe the criteria of acquired immunity.

**Answer:** Acquired (adaptive) immunity is an antigen-specific defense that develops after exposure to a foreign substance and provides long-lasting protection. Its main criteria are:

1) **Specificity:** Targets specific antigens; hence called the third line of defense.
2) **Develops after exposure:** Not present at birth; develops after infection or vaccination.
3) **Antigen-specific response:** Acts only against the recognized pathogen.
4) **Lymphocyte-mediated:**
   - **T-lymphocytes:** Responsible for cell-mediated immunity.
   - **B-lymphocytes:** Produce antibodies for humoral immunity.
5) **Systemic action:** Provides protection throughout the body.
6) **Immunological memory:** Produces a faster and stronger response on re-exposure.
7) **Enhances innate immunity:** Works together with innate defenses to eliminate pathogens.

*[Ref: Akram, Immunology, 7th ed., p. 20]*

Q. Classify acquired immunity with examples.

**Answer:** Acquired (adaptive) immunity is classified based on the source of antibodies into active and passive immunity.

A. **Active Immunity :** *(Antibodies are produced by the individual's own immune system)*
   1) **Natural active immunity:** Acquired after natural infection.
      **Examples:** Measles, mumps, hepatitis A.
   2) **Artificial active immunity:** Acquired through vaccination.
      **Examples:** BCG, polio vaccine, tetanus toxoid.

**B. Passive Immunity *(Ready-made antibodies are transferred to the individual)***
   1) **Natural passive immunity:** Antibodies passed from mother to child via placenta or breast milk.
      **Example:** Maternal antibodies (IgG, IgA).
   2) **Artificial passive immunity:** Antibodies administered from external sources.
      **Examples:** Tetanus immunoglobulin (TIG), rabies immunoglobulin (RIG).

*[Ref: Akram, 7th ed., p. 20; Sharif, 8th ed., p. 107]*

Q. Mention how acquired immunity can be enhanced artificially

**Answer:** Acquired immunity can be artificially enhanced in the following ways:

1) **Artificial Active Immunity:** Antigens are introduced into the body to stimulate the immune system to produce its own antibodies.
   **By vaccination**, such as:
   - **Bacterial vaccines:** Typhoid
   - **Viral vaccines:** Polio, measles
   - **Toxoids:** Tetanus toxoid
   - **Live attenuated vaccines:** BCG, MMR
2) **Artificial Passive Immunity:** Ready-made antibodies are administered to provide immediate but short-term protection.
   **By injection of preformed antibodies**, such as:
   - Tetanus immunoglobulin (TIG)
   - Anti-tetanus serum (ATS)
   - Anti-diphtheria serum (ADS)

*[Ref: Sharif, 8th edition, p. 107]*

Q. Compare between innate and acquired immunity. What is the basic difference between them?
***Basic difference:*** Innate immunity is the first line of defense, present from birth and non-specific, whereas acquired immunity develops after exposure to antigens and is highly specific with immunological memory.

Table-19.1 Comparison between Innate and Acquired Immunity

| Trait | Innate Immunity | Acquired Immunity |
|---|---|---|
| Time of development | Present from birth | Develops after birth on exposure to antigen |
| Specificity | Non-specific | Highly antigen-specific |
| Response to repeated exposure | Same response each time | Faster and stronger secondary response |
| Immunological memory | Absent | Present |
| Presence in organisms | Present in vertebrates and invertebrates | Present only in vertebrates |
| Mechanical barriers | Present (skin, mucous membranes) | Absent |
| Main cells involved | Macrophages, neutrophils, NK cells | T-lymphocytes and B-lymphocytes |
| Speed of response | Immediate (minutes to hours) | Delayed (days) |

Q. What are the cells and secreted molecules of innate and acquired immunity?

Table-19.2 **The cells and secreted molecules of innate and acquired immunity**

| Immunity | Cells | Secreted Molecules |
|---|---|---|
| Innate immunity | Polymorphonuclear leukocytes (neutrophils), eosinophils, macrophages, natural killer (NK) cells, lymphokine-activated killer (LAK) cells | Cytokines, complement proteins, antimicrobial peptides |
| Acquired immunity | B-lymphocytes, T-lymphocytes (with help from macrophages and other antigen-presenting cells) | Antibodies (immunoglobulins), cytokines, complement proteins |

*[Ref.:. Akram,* Immunology, *7th edition, p. 21; Choudhury, 5th edition, p. 98]*

# Active Immunity

Q. Define active immunity with its advantages and disadvantages.
**Definition of active immunity:** Active immunity is a type of acquired immunity in which the host's immune system produces its own antibodies and memory cells in response to exposure to antigens, either by natural infection **or** vaccination.
**Advantages of Active Immunity:**

1) **Long-lasting protection:** Provides protection for many years or lifelong due to memory cells (e.g., measles, MMR vaccine).
2) **Immunological memory:** Produces a faster and stronger response on re-exposure.
3) **Safe through vaccination:** Vaccines induce immunity without the risks of natural infection.
4) **Boostable:** Immunity can be enhanced with booster doses (e.g., tetanus toxoid).
5) **No serum allergy:** Does not cause hypersensitivity reactions seen with animal-derived antisera.

**Disadvantages of Active Immunity:**

1) **Delayed onset:** Protection develops slowly (days to weeks).
2) **Multiple doses needed:** Some vaccines require booster doses.
3) **Not suitable for immunocompromised individuals:** Live vaccines may be unsafe (e.g., BCG, MMR).
4) **Mild side effects:** Fever, pain, or swelling may occur after vaccination.
5) **Variable response:** Some individuals may not develop adequate immunity.

*[Ref: LANGE Review, 17th ed., pp. 496–497]*

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# Passive Immunity

Q. Define passive immunity with its advantages and disadvantages.

**Definition:** Passive immunity is a type of acquired immunity in which pre-formed (ready-made) antibodies are transferred from another individual (human or animal) to provide immediate but temporary protection against infection.

**Advantages of Passive Immunity:**

1) **Immediate protection:** Acts rapidly; useful in emergencies such as rabies or snakebite.
2) **Useful in immunocompromised patients:** Effective when the host cannot produce antibodies.
3) **Temporary protection:** Provides protection until active immunity develops after vaccination.
4) **Both preventive and therapeutic:** Used after exposure or during infection (e.g., hepatitis B immunoglobulin).
5) **No antigen exposure required:** Protection is achieved without prior infection or immune response.

**Disadvantages of Passive Immunity:**

1) **Short duration:** Protection lasts only for weeks due to absence of memory cells.
2) **No immunological memory:** Does not provide long-term protection.
3) **Risk of hypersensitivity reactions:** Serum sickness or allergies may occur, especially with animal sera.
4) **Expensive and limited availability:** Production and supply can be costly.
5) **Interference with vaccines:** Passive antibodies may reduce the effectiveness of live vaccines.

*[Ref: LANGE Review, 17th ed., pp. 496–497]*

Q. Different between active and passive immunity

Table19.3 Differences between Active and Passive Immunity

| Trait | Active Immunity | Passive Immunity |
|---|---|---|
| Source of antibodies | Produced by host | Given from outside |
| Onset | Slow | Immediate |
| Duration | Long-lasting | Short-lived |
| Memory cells | Present | Absent |
| Secondary response | Present | Absent |
| Use | Prevention (vaccines) | Immediate protection |
| Suitability | Not ideal for immunocompromised | Useful for immunocompromised |
| Cost | Less expensive | More expensive |

*[Ref: Akram, Immunology, 7th ed., **p. 21;** p. 21; LANGE Review, 17th ed., pp. 496–497]*

Q. How is active immunity produced?

**Answer: Active immunity** is produced when the host's immune system responds to a foreign antigen by forming **antibodies and memory cells.**

**It develops in** three ways**:**

1) **After clinical infection** – e.g., chickenpox, measles
2) **After subclinical infection** – e.g., mild or unnoticed polio, diphtheria
3) **After vaccination** – using killed vaccines, live attenuated vaccines, or toxoids

*[Ref: Sharif, 8th ed., p. 107]*

Q. How is passive immunity produced?

**Answer:** Passive immunity is produced by the transfer of pre-formed antibodies or immune cells to an individual, giving immediate but temporary protection.

It is produced in three ways:

1) **Administration of antibodies** – Injection of antiserum or immunoglobulins (e.g., ATS, ADS, TIG).
2) **Transfer of maternal antibodies** – IgG crosses the placenta; IgA is provided through breast milk.

3) **Transfer of lymphocytes** – Rarely, passive cellular immunity via lymphocyte transfer.

*[Ref: Sharif, 8th ed., p. 107]*

Q. Name of center organ of immune system

**Centre (Primary) organs of the immune system:**

1) **Bone marrow** – site of formation and maturation of B-lymphocytes
2) **Thymus** – site of maturation of T-lymphocytes

*[Ref. Akram/Immunology/7th edition/29]*

# Cells and Organ of Immune System

Q. Name the cells of acquired immunity.

**Cells of acquired immunity:**

1) **B lymphocytes** – produce antibodies (humoral immunity)
2) **T lymphocytes** – mediate cell-mediated immunity
3) **Macrophages** – antigen presentation to T cells

*[Ref: Sharif, 8th ed., p. 108]*

Q. Name the cells and organs of acquired immunity. Compare between T-cell and B-cell.

**Cells of Acquired Immunity:**

1) T-lymphocytes (T cells)
2) B-lymphocytes (B cells)
3) **Macrophages** – antigen-presenting cells (APCs)
4) **Dendritic cells** – major APCs

**Organs of Acquired Immunity:**

1) **Central (Primary) lymphoid organs**
   - **Thymus** – maturation of T-lymphocytes
   - **Bone marrow** – development of B-lymphocytesn*(Fetal life: B-cell development also occurs in fetal liver)*
2) **Peripheral (Secondary) lymphoid organs**
   - **Lymph nodes**
   - **Spleen**
   - **Mucosa-associated lymphoid tissue (MALT)** – tonsils, Peyer's patches

Table- 19.4 **Comparison between T-Cell and B-Cell:**

| Feature | T-Cell | B-Cell |
|---|---|---|
| Origin | Bone marrow | Bone marrow |
| Maturation site | Thymus | Bone marrow *(fetal liver in fetus)* |
| Surface receptor | T-cell receptor (TCR) | B-cell receptor (BCR = surface immunoglobulin) |
| Antigen recognition | Processed antigen with MHC | Native (free) antigen |
| Main function | Cell-mediated immunity | Humoral immunity (antibody production) |
| Subtypes | Helper T cells, Cytotoxic T cells | Plasma cells, Memory B cells |

*[Ref:. Akram, Immunology, 7th ed., p. 21, 29–30]*

Q. Name secreted molecules of both innate and acquired immunity

***Secreted molecules of innate immunity:***

1) **Complement proteins** – opsonization and lysis of pathogens
2) **Cytokines** – e.g., interferons, interleukins, TNF
3) **Acute phase proteins** – e.g., C-reactive protein (CRP)
4) **Defensins & antimicrobial peptides** – directly kill microbes

***Secreted molecules of acquired immunity:***

1) **Antibodies (immunoglobulins)** – specific pathogen neutralization
2) **Cytokines** – mainly from T lymphocytes
3) **Complement (antibody-dependent activation)**

*[Ref: Sharif, 8th ed., p. 108]*

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